MiniDrive™
MODEL 200

QNTX TM 1000

Reference Manual

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SECTION 1

GENERAL DESCRIPTION

1.1 GENERAL

This manual contains general description, installation instructions, theory of operation, maintenance and troubleshooting procedures, parts list, and schematics for the Model 200 MINIDRIVE™ (Model 200).

1.2 PHYSICAL DESCRIPTION

The Model 200 (fig. 1-1) is designed to be an OEM system component. Its flexible design offers a wide range of options to allow the system designer to choose both the control parameters and mechanical mounting configuration best suited to his system design concept and application. The unit can be operated in any attitude (vertical or horizontal).

The Model 200 is available, in its simplest form, as a mechanism only with intimate electronics, which includes:

- Optical tachometer
- Motor driver circuit
- Tape hole detector circuit
- Debounced Cartridge-in-Place and File Protect
- Track selection logic
- Write head drivers
- Read head preamp

The Model 200 is also offered with a servo/data card which contains the velocity servo and read-write circuits, and the control logic card which contains the housekeeping and user interface circuits.

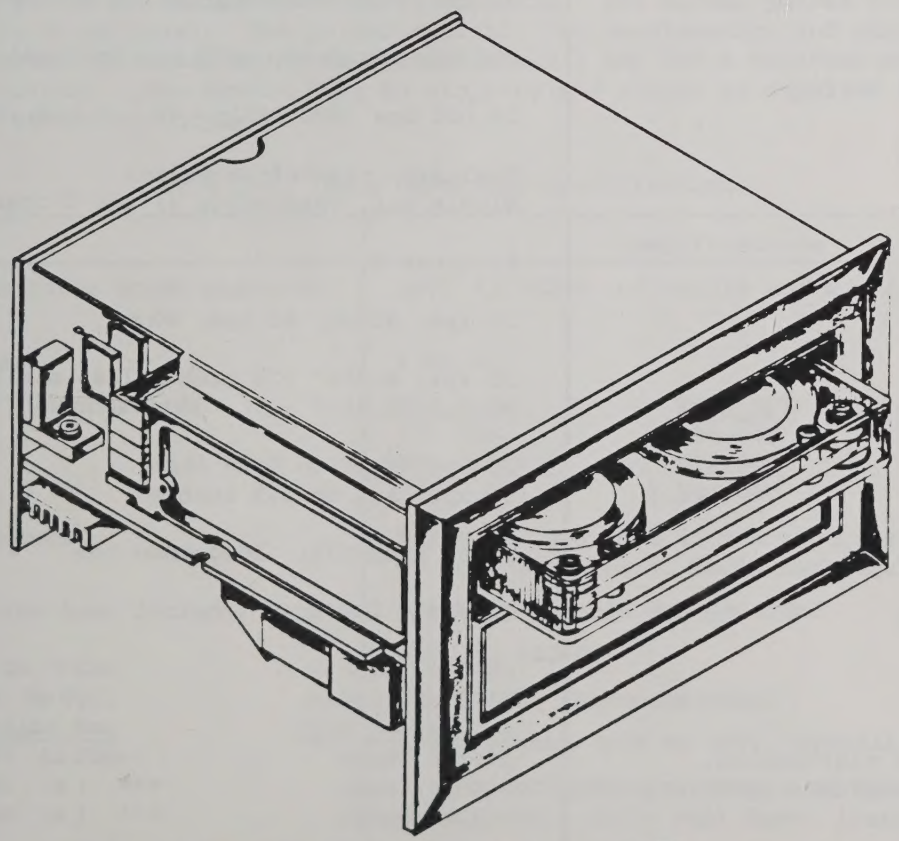


Figure 1-1. Model 200 MINIDRIVE™

1.3 FUNCTIONAL DESCRIPTION

The Model 200 is a high-performance tape drive that uses the miniature 3M DC100A data cartridge.

In its fullest configuration, the Model 200 provides the following housekeeping functions:

- Auto Load (Auto Rewind when cartridge inserted)
- Rewind (not allowed at Load Point)
- Unload (reverse high speed and off-line to BOT from any point in the tape)
- No forward motion at EOT (automatic reverse motion regardless of command)
- No reverse motion at BOT
- Writing inhibited in reverse

1.4 SPECIFICATIONS

Tables 1-1 and 1-2 provide electrical and physical specifications for the Model 200 and the data cartridge, respectively.

Table 1-1. Model 200 Specifications

Item	Specifications
Medium	"Scotch" Brand DC100A cartridge, 140 ft. of 0.150 in. tape, or equivalent
Speed	30 ips write, bidirectional read; 90 ips, bidirectional search and rewind
Recording density	800 bip standard, 1600 bpi optional
Transfer rate	24,000 bps (800 bpi); 48,000 bps (1600 bpi)
Head type	Dual gap, read-after-write; Single gap, read/write (1 and 2 track only)
Tracks	1, 2, or 4
Start-stop time	30 ips, 30 ms; 90 ips, 90 ms
Start distance*	30 ips, 0.565" (75 tach pulses min); 90 ips, 1.695"
Stop distance	30 ips, 0.11 to 0.14 inch; 90 ips, 1.1 to 1.5 inches
Speed variation	Short term ±2%; long term ±3%
Interface logic	TTL/DTL, Low true (control card only)
Power	+5 V ±0.25 V (100 mV ripple and noise, max) / +12 V ±0.6 V (100 mV ripple and noise, max)
With intimate electronics	100 mA (max) / **800 mA (max)
Including servo/data card (opt -SDC)	600 mA (max) / *** 1 A (max)
Including control board (opt -CLC)	1 A (max) / *** 1 A (max)
Ambient temperature (see para. 2.7)	
Operating	-5° to +55°C dry bulb; 26°C wet bulb
Storage	-30° to +60°C

Table 1-1. Model 200 Specifications (Continued)

Item	Specification
Relative humidity	
Operating (excluding media)	20 to 90% (no condensation)
Storage	0 to 95% (no condensation)
Dimensions	
Drive with intimate electronics	3"H x 4.12"W x 4.156"D (7.62 x 10.46 x 10.56 cm)
Servo/data or control logic card	4.5" x 6" (11.4 x 15.2 cm)
Card cage (without drive installed)	3.75"H x 4.7"W x 7.4"D (9.5 x 11.9 x 18.9 cm)
Weight	
Drive (with intimate electronics)	1 lb. (450 gr)
Drive with card cage	2.1 lbs. (1100 gr)
Servo/Data or control logic card	0.5 lb. (225 gr) each

*Start distance can be held precisely if tach output is used to determine where to start writing. Minimum number of tach pulses before writing is 75. Each tach pulse is equivalent to 0.0076 inches. Qantex recommends that the minimum number of tach pulses be increased to 80 to add additional reliability margins.

**2 amp pulse for 20 ms during starting or stopping.

**2.2 amp pulse for 20 ms during starting or stopping. The normal pulses current due to acceleration is 2 amp (max). The pulsed current, for deceleration and stopping, is preceded by a current switching spike of approximately 3 amp for a duration of 10 µs to 20 µs. This current spike occurs only on stopping and should be supplied by the storage capacitors in the power supply.

Table 1-2. Data Cartridge Specifications

Item	Specifications	
Tape length (computer grade magnetic tape)	140' (37.63 m) of usable storage (min)	
Number of tracks	1 or 2	
Capacity bytes (unformatted)	800 bpi	1600 bpi
1 track	168,000	336,000
2 track	336,000	672,000
4 track	---	1,344,000
Tape position sensing	Holes are provided in the tape for optical sensing of BOT, Load Point, Early Warning, and EOT.	
File protect	Operator movable tab provided	
Temperature	+0°C to +50°C	
Humidity	20% to 80% (noncondensing)	
Operating life	5,000 passes (BOT to EOT), typcial	
Construction	High-impact plastic cover over heavy gauge metal base plate	
Size	2.4" x 3.2" x 0.5" (6.12 x 8.10 x 1.19 cm)	
Weight	2 ounces (56.7 gr)	

1.5 CONFIGURATION OPTIONS

The Model 200 is available in various configurations as detailed in subsequent paragraphs and table 1-3.

Table 1-3. Model 200 Configuration Options

Option	Description	Part No.
	BASIC DRIVES	
Model 200-1S-8 (800 BPI)	One track, single gap	786674
-1D-8	One Track, dual gap	786676
-2S-8	Two track, single gap	786675
Model 200-2S-16 (1600 BPI)	Two track, single gap	786679
-2D-16	Two track, dual gap	786681
-4D-16	Four track, dual gap	786802
	ELECTRONICS	
Servo data card	See Note 1 -SDC For 1S-8 and 2S-8 drives	786660
	For 1D-8 and 2D-8 drives	786635
	For 1S-16 and 2S-16 drives	786661
	For 1D-16 and 2D-16 drives	786616
Control logic card	See Note 2 -CLC	786615
	MOUNTING HARDWARE	
Drive card cage	See Note 3 -DF or -DR	786628 (inc. -BP)
Backplane only	See Note 3 -BP	786642
Bezel	-BZ	296274
Backplane I/O connector cable		786655
Backplane power cable		786656
	CABLES	
See figure 2-2 for illustration of cable configurations and requirements.		
*Drive to servo data card cable set (2 cables)		786662
**Servo data card to user cable set (2 cables)		786663
***Servo data card to control logic card and user (3 cables)		786664
	DATA CARTRIDGES	
Data cartridge		883083

NOTES:
1. Requires cables marked by * and **.
2. Requires a servo data card, -SDC, and ONLY cables marked by ** and ***.
3. When backplane or drive card cage is ordered, cables marked by * are required, and cables marked by ** and *** are NOT required. Instead, order backplane I/O cable, P/N 786655, and backplane power cable, P/N 786656.

1.5.1 Electrical

1.5.1.1 Intimate Electronics

The basic assembly is termed the Model 200 with intimate electronics. This includes the drive deck with all necessary electromechanical parts plus certain analog circuitry. The signal descriptions for the intimate electronics interface is presented in table 1-4. The intimate electronics consists of two small printed circuit cards; read/write and status drive. Connections to these boards are made to a 26-pin edge connector on the status board and a 14-pin dip socket on the read/write board. Unless otherwise specified, all signals are TTL logic levels. This interface does include analog signals. Mounting of the Model 200 with intimate electronics assembly is accomplished by the three mounting holes in the deck plate.

Table 1-4. Intimate Electronics Signal Description

Connector	Signal	Function
		STATUS BOARD - OUTPUT SIGNALS
J1-13	TMS	(A)* Positive pulses at least 40 µs long which indicate the presence of a tape mark hole. There will be at least one pulse per hole at high speed.
J1-16	$\overline{\text{TMS}}$	Complement of above
J1-20	Latched TMS	Positive level which will appear at detection of first TMS pulse.
J1-9	TMS Safe	Positive level indicating that there is power on the TMS LED and tape is present between LED and sensor.
J1-17	$\overline{\text{FP}}$	Negative level which indicates that the file protect switch is active, i.e., write protected.
J1-15	IRDY	Positive level which indicates that the cartridge is in place and the tachometer LED is functioning.
J1-11	Sync	Series of pulses from the optical tachometer. The frequency of the pulse train is directly proportional to the speed of the motor and therefore, the tape. Pulse-to-pulse equals 0.0076 inches.
		STATUS BAORD - INPUT SIGNALS
J1-18	$\overline{\text{Reset TMS}}$	Low-going pulse at least 250 ns to reset TMS latch. CAUTION Care must be taken in activating these signals. Activation of FSD and REV switch or RSD and FWD switch at the same time for more than 1 µS can cause damage to the servo drivers.

Table 1-4. Intimate Electronics Signal Description (Continued)

Connector	Signal	Function
J1-8	FSD	Forward servo drive is an analog voltage, which, when varied from 0 volts to +12 volts will drive the motor in a forward direction. The magnitude of the voltage will determine the speed of the motor. Current is limited through a 51 ohm resistor. This must be used in conjunction with FWD switch. CAUTION Care must be taken in activating these signals. Activation of FSD and REV switch or RSD and FWD switch at the same time for more than 1 µS can cause damage to the servo drivers.
J1-12	REV Switch	This input is pulled up to +5 volts through 330 ohms and should be driven by an open collector driver. This input allows current flow through the motor from RSD when reverse motion is required.
J1-21,22	Motor Return	This is a ground connection which must be brought to the common power supply ground.
J1-4,23	Ground	Ground connection for signal ground
J1-1,2	+12 VS	Regulated +12 volts, ±.6 volts capable of 800 mA steady state and 2.0 amp pulsed for 20 milliseconds.
J1-7	+12 V	LED voltage for TMS, 75 mA pulsed for at least 40 µs every 150 µs. Also supplies power for TMS circuits on this board.
J1-6	LED Return	This is a ground connection which must be returned separately to the common power supply ground.
J1-3,24	+5 V	Regulated +5 volts, ±0.25 volts, 100 mA. CAUTION Care must be taken in activating these signals. Activation of FSD and REV switch or RSD and FWD switch at the same time for more than 1 µS can cause damage to the servo drivers.
J1-10	RSD	Reverse servo drive is an analog voltage which when varied from 0 volts to +12 volts will drive the motor in a reverse direction. The magnitude of the voltage will determine the speed of the motor. Current is limited through a 51 ohm resistor. This must be used in conjunction with REV switch.

Table 1-4. Intimate Electronics Signal Description (Continued)

Connector	Signal	Function
		CAUTION **Care must be taken in activating these signals. Activation of RSD and REV switch or RSD and FWD switch at the same time for more than 1 µS can cause damage to the servo drivers.**
J1-14	FWD Switch	This is pulled up to +5 volts through 130 ohms, and should be driven by an open collector driver. This input allows current flow through the motor from FSD when forward motion is required.
		READ/WRITE CONNECTIONS - INPUT SIGNALS
J2-12	$\overline{\text{TK SEL A}}$	Low level for Track 1 and high level for Track 2 in a two track system. Low all the time in a one track system. Most significant bit.
J2-5	$\overline{\text{TK SEL B}}$	Second track select for 4 track drive only. Least significant bit.
J2-3	$\overline{\text{Write}}$	Low to enable write, TTL level. In signal gap head, low level also blocks read preamp.
J2-2	Write Data	Encoded data to be written on tape.
J2-13	$\overline{\text{Write PWR}}$	Low level enables write current in head. Driver must be open collector output capable of +12 volts in off state.
J2-14	Ground	Write ground
J2-7	+12 V	Separate +12 volts from servo.
J2-4,11	+6 V	Regulated to ±5% with 50 mA capability must be twisted with +ANRD and -ANRD signals. This voltage is derived from a simple zener regulator operating from +12 volts. This circuit is located on the servo/data card.
J2-1	+5 V	Regulated +5 volts, ±0.25 volts, 100 mA.
J2-8	Read Ground	This ground must be returned separately to the next stage read amplifier.
		READ/WRITE CONNECTIONS - OUTPUT SIGNALS
J2-9	$\overline{\text{ANRD}}$	Analog filtered differential read signals from head.
J2-10	ANRD	Levels are from 750 millivolts to 1.5 volts peak-to-peak, around a reference voltage of 6.0 volts.

1.5.1.2 Servo/Data Card (-SDC)

The servo data card is the next level of electronics to be added to the intimate electronics configuration. The servo/data card contains the complete velocity servo and the read/write circuits

The capstan velocity is servo-controlled during start/stop modes and is held at a constant value during reading or writing. The feedback information is a pulse train derived from an optical tachometer mounted on the motor assembly. The servo system achieves a repeatable velocity profile.

Serial input data is accepted as phase-encoded data. The write amplifier conditions the data input and drives the write head.

The Model 200 was designed for serial recording on 1 or 2 tracks, phase-encoded 800 or 1600 bpi (1600 or 3200 fci). Data output is an image of the data recorded. The recording format can be compatible with the proposed ANSI specification, X3.56-1977, Recorded Magnetic Tape Cartridge for Information Interchange.

Data from a selected track is switched to a separate read amplifier. This amplifier utilizes level discrimination and peak detection to reproduce the original logic signal. Since the Model 200 is also available with a dual-gap head, the amplifier provides a dual threshold capability. The threshold is positioned at 22.5 percent for read-after-write, and at 10 percent for read.

With the SDC option, all I/O signals are TTL compatible and provide a generalized interface to a user or the control logic card. The servo/data card contains an IC socket connector to accept the J1 signals from the read/write electronics. In addition, a 26-pin connector (J2) contains signals from the status electronics, and a 20-pin edge connector (P3), contains the logic of the servo/data card. Power connections are made thru P4, which is a 40-pin edge connector. A complete signal description of this interface is provided in table 1-5.

Table 1-5. Servo/Data Card Signal Description

Connector	Signal	Function
		OUTPUT SIGNALS
P3-B33	$\overline{\text{Read Data}}$	This is phase-encoded read data which can be bussed and must be terminated with a 220/330 ohm termination.
P3-B32	$\overline{\text{TMS}}$	Low-going pulses of at least 40 µs, indicates presence of a Tape Mark hole. There will be at least one pulse per hole at high speed.
P3-B29	$\overline{\text{RDY}}$	(F)* A low level which indicates that cartridge is in place and tach and TMS are operational.
P3-B31	FP	A positive level which indicates that the cartridge is file protected.
P3-A31	TACH	Series of pulses which indicate that the servo motor is rotating. Each pulse represents a fixed distance of tape movement, regardless of tape speed. The frequency of the pulse train is directly proportional to the tape speed. Each pulse represents a distance of 0.0076 inches of tape at 30 ips.

*The letters in parenthesis refer to waveforms in figures 3-1 thru 3-3 and 3-6 thru 3-8.

Table 1-5. Servo/Data Card Signal Description (Continued)

Connector	Signal	Function
		INPUT SIGNALS
P3-A29	$\overline{\text{ITR}}$	(G)* This is a low level which will cause tape to move in either forward or reverse direction.
P3-B30	$\overline{\text{FWD}}$	(D)* A low level on this line, in conjunction with $\overline{\text{ITR}}$, will move tape in the forward direction; a high level will move tape in the reverse direction.
P3-A30	$\overline{\text{Fast}}$	(C)* A low level on this line, in conjunction with $\overline{\text{ITR}}$, will move tape at high speed, and a high level will move tape at the read/write speed.
P3-B34	$\overline{\text{WREN}}$	Low level will activate write current in head if cartridge is not file protected.
P3-A32	$\overline{\text{TK SEL A}}$	Low level selects track one and high level selects track two. In a single track drive, this line must be held low. Most significant bit.
P3-B35	$\overline{\text{TK SEL B}}$	Second track select for 4 track drives only. Least significant bit.
P3-A33	WR Data	Encoded data to be written on tape.
P3-B28,A28	+5 V	5 volt bus connection from power connector. This line is used to power the control logic card.
P3-B27,A27	Ground	Ground bus connector from power connector. This line used for the ground return for the control logic card.
P4-A6,B6	+12 VS	Regulated +12 volts, ±0.6 volts capable of 1 A steady state and 2.2 A pulsed for 20 milliseconds. This requirement includes the status board and read/write board load.
P4-A1,B1	+5 V	Regulated +5 volts, ±0.25 volts capable of 600 mA, maximum. This requirement includes the status board and read/write board load.
P4-A2,B2	Ground	Signal ground
P4-A3,B3	+12 V	Regulated +12 volts, ±0.6 volts, same as P4-A6,B6, except separately filtered.
P4-A4,B4	Motor Return	Servo ground returned separately to power supply.
P4-A20	Read Ground	Ground returned separately to power supply.

*The letters in parenthesis refer to waveforms in figures 3-1 thru 3-3 and 3-6 thru 3-8.

1.5.1.3 Control Logic Card (-CLC)

The control logic card provides the housekeeping functions described in paragraphs 1.1 through 1.3. In addition, it allows programming the drive address and provides bussable outputs.

All bussed outputs are from open collector IC's, Type 7438. They are controlled by the internal SELECT. Up to four Model 200 tape drives may be bussed together, since each tape drive can decode a two bit address. Provisions are made on the control logic card to program any address. Unless specified, the address will be factory programmed to zero.

All inputs to the Model 200 are terminated in a resistive network containing a 220 ohm resistor to +5 vdc and a 330 ohm resistor to ground. All user receiving circuits should be similarly terminated. For multiple drive systems, the termination network must be removed from all tape drives except the one at the end of the line. This is easily accomplished since the termination networks are contained in a DIP package installed in a conventional IC socket. The board contains two edge connectors. P5 is a 20-pin edge connector which has, pin for pin, the same signals as P3 on the servo/data board. It is suggested that these connections be made via a flat ribbon cable with 20-pin connectors. Alternatively, the boards may be plugged into a backplane and interconnection be made at that level. P6 (40-pin edge connector) is the I/O connector and has 11 of the bussed interface connections as alternating signals and grounds with twisted pairs or flat ribbon cable. J3 is completely TTL compatible. A description of the I/O interface for the control logic card is given in table 1-6.

Table 1-6. Control Logic Card Signal Description

Connector	Signal	Function
		INPUT SIGNALS
P5-B28	+5 V	Regulated +5 volts ±0.25 volts at 400 mA
P5-B27	Ground	Separate signal ground to power supply
P6-A9	$\overline{\text{Sel A}}$	Low level active - most significant drive select bit
P6-A8	$\overline{\text{Sel B}}$	Low level active - least significant drive select bit
P6-A4	$\overline{\text{TRC}}$	(N)* Low level active - causes drive to move if selected and ready.
P6-A3	$\overline{\text{RWDC}}$	(J)* Low-going pulse 250 ns to 2 µS. If the drive is selected and ready, this pulse will cause drive to rewind to BOT, seek Load Point and stop. (RWDC will not cause a Rewind if drive is already positioned at Load Point.)
P6-A6	$\overline{\text{UNLDC}}$	Low-going pulse 250 ns to 2 µS. Causes drive to unload tape by positioning at BOT and deselecting the drive. It will be necessary to eject the cartridge and reinsert it to reselect the drive. (Unload will work with drive positioned at Load Point.)
P6-A5	Read/$\overline{\text{Write}}$	(S)* Low level activates write current in head if drive is selected and ready and not file protected. In a single gap drive, a low level also disables the read circuits.

*The letters in parenthesis refer to waveforms in figures 3-1 thru 3-3 and 3-6 thru 3-8.

Table 1-6. Control Logic Card Signal Description (Continued)

Connector	Signal	Function
P6-A12	TK SEL A	High level selects track one; low level selects track two. In a single track drive this line must be low. Most significant bit.
P6-A2	TK SEL B	Second track select line for 4-track drive only. Least significant bit.
P6-A11	WR Data	(O)* Encoded data to be written on tape.
P6-A7	$\overline{\text{FWDC}}$	Low level causes forward motion when $\overline{\text{TRC}}$ active. High level causes reverse motion.
P6-A10	$\overline{\text{Fast C}}$	Low level causes fast forward motion when $\overline{\text{TRC}}$ active. High level causes slow (read/write) speed.
	OUTPUT SIGNALS (Only active when drive is selected and Ready)	
P6-A14	$\overline{\text{LPO}}$	(I)* Low level indicates drive is stopped at Load Point.
P6-A15	$\overline{\text{EWO}}$	(L)* Low level indicates that an Early Warning is detected while moving forward. Early warning status will remain active until the Early Warning hole is detected in the reverse direction.
P6-A16	$\overline{\text{EOTO}}$	(K)* Low level indicates drive is stopped at EOT hole. Drive will not respond to any forward command. The EOT status will remain active until the EOT hole is detected in reverse. It is necessary to drop tape run, set reverse, and enable tape run again in order to cause reverse motion. (If forward motion is commanded while tape is at EOT, the drive will move reverse.)
P6-A17	FPO	High level indicates that cartridge is file protected.
P6-A19	$\overline{\text{Read Data}}$	(R)* Phase-encoded read data
P6-A18	$\overline{\text{READYO}}$	(M)* Low level indicates drive is selected and ready.
P6-A13	$\overline{\text{TACHO}}$	(P)* Series of low-going pulses indicating tape motion. Each pulse represents a fixed distance of tape moved regardless of speed.

*The letters in parenthesis refer to waveforms in figures 3-1 thru 3-3 and 3-6 thru 3-8.

NOTE: $\overline{\text{LPO}}$, $\overline{\text{EWO}}$ and $\overline{\text{EOTO}}$ are latched signals.

1.5.2 Mechanical

1.5.2.1 Discrete Assemblies

This configuration provides the Model 200 frame with intimate electronics, the servo/data card and the control logic card as separate subassemblies. It is the responsibility of the user to provide the necessary mounting required for the drive frame and the electronic cards. Refer to table 1-3 for configuration and accessories.

1.5.2.2 Drive-Card Cage (-DF or -DR)

For a simplified installation, Qantex offers a small mechanical frame which will accept the three subassemblies (Minidrive, servo/data, and control logic cards) and provide the necessary interconnects via a miniature printed circuit backplane. I/O signals to the user is thru a 40-pin ribbon connector (Ansley part number 609-4000M). Power is introduced to the backplane thru a 4-pin connector (Molex part number 03-06-1042). This connector is polarized by virtue of the housing. Use female contacts (Molex part number 02-06-1103). Power and data I/O cables are available (see table 1-4).

This mounting frame can be mounted in either of two ways. The basic difference is whether the user desires the capability of front or rear card removal. In either case, the drive frame is hard mounted to the drive-card cage. Refer to figures 1-2 and 1-3 for this configuration.

1.5.2.3 Backplane (-BP)

The backplane provides the user with a simple way of connecting the servo/data card to the control logic card. The power for both cards and the drive frame and the I/O signals for the control card are conveniently terminated on the backplane. The I/O signals and power are introduced to the backplane via two cables, part number 786655 and part number 786656, respectively. The backplane is also used with the drive card cage.

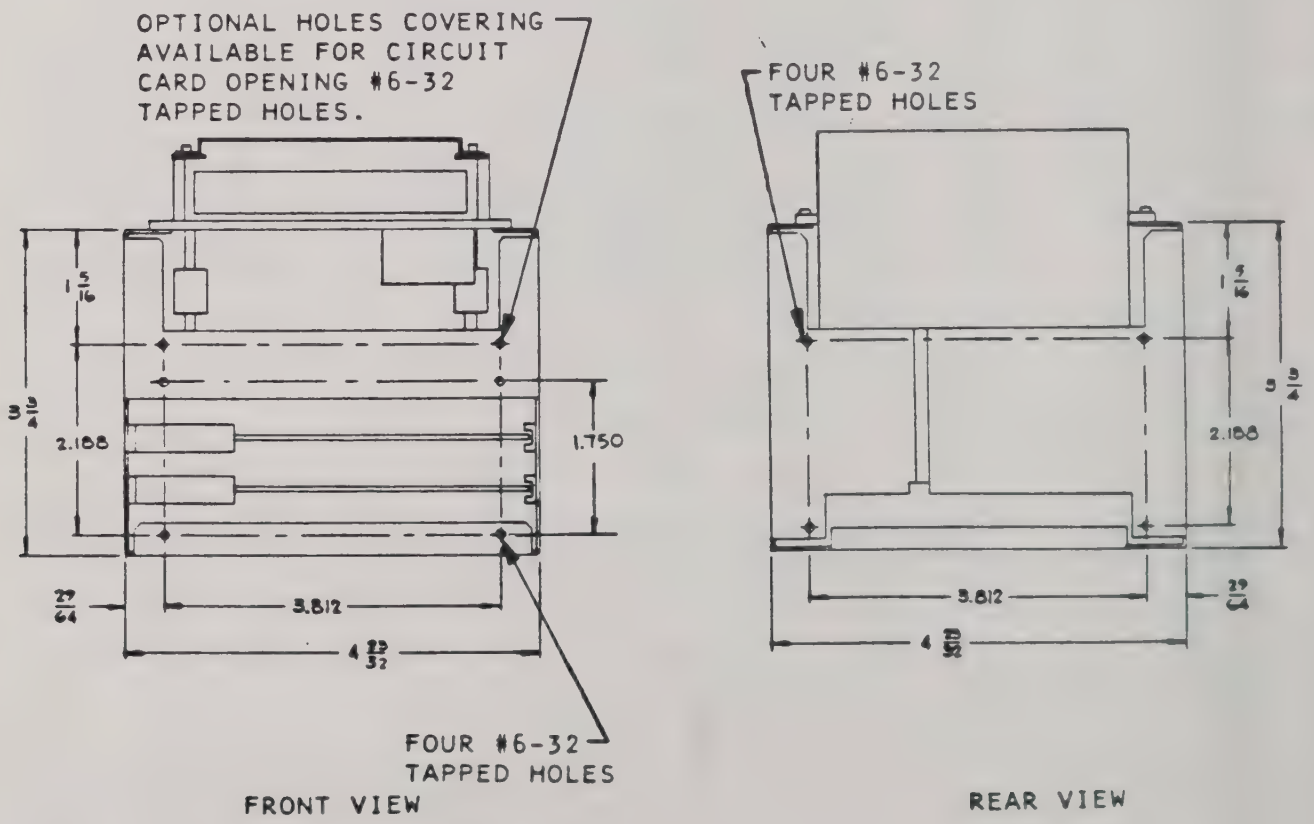


Figure 1-2. Card Cage, Front Exit Circuit Cards (Sheet 1 of 2)

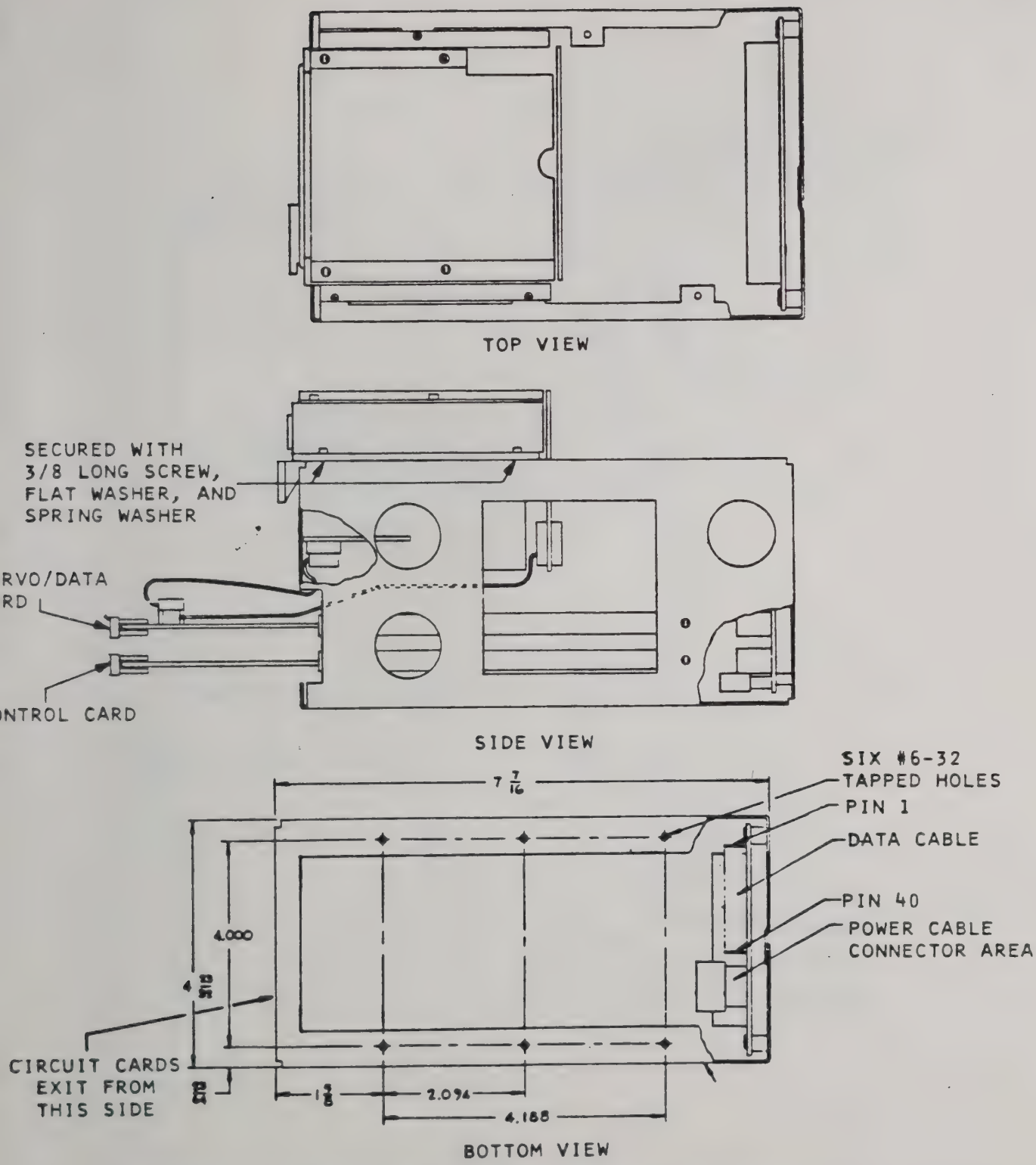
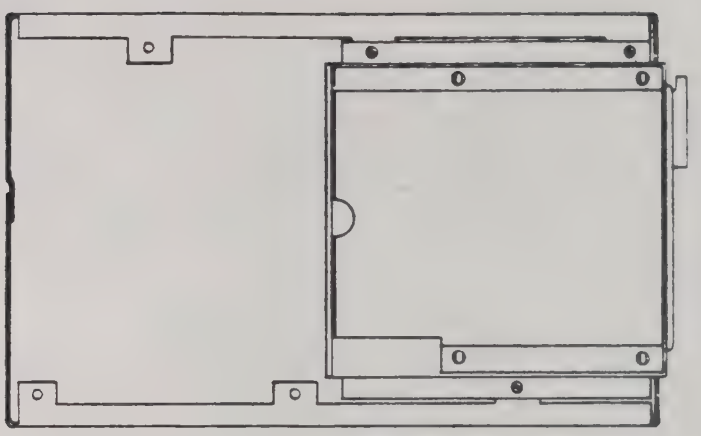
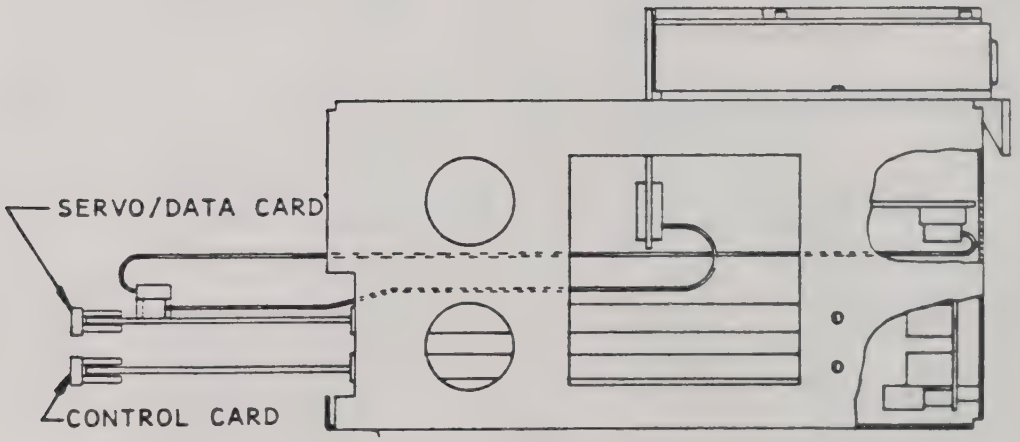


Figure 1-2. Card Cage, Front Exit Circuit Cards (Sheet 2 of 2)



TOP VIEW



SIDE VIEW

Figure 1-3. Card Cage, Rear Exit Circuit Cards (Sheet 1 of 2)

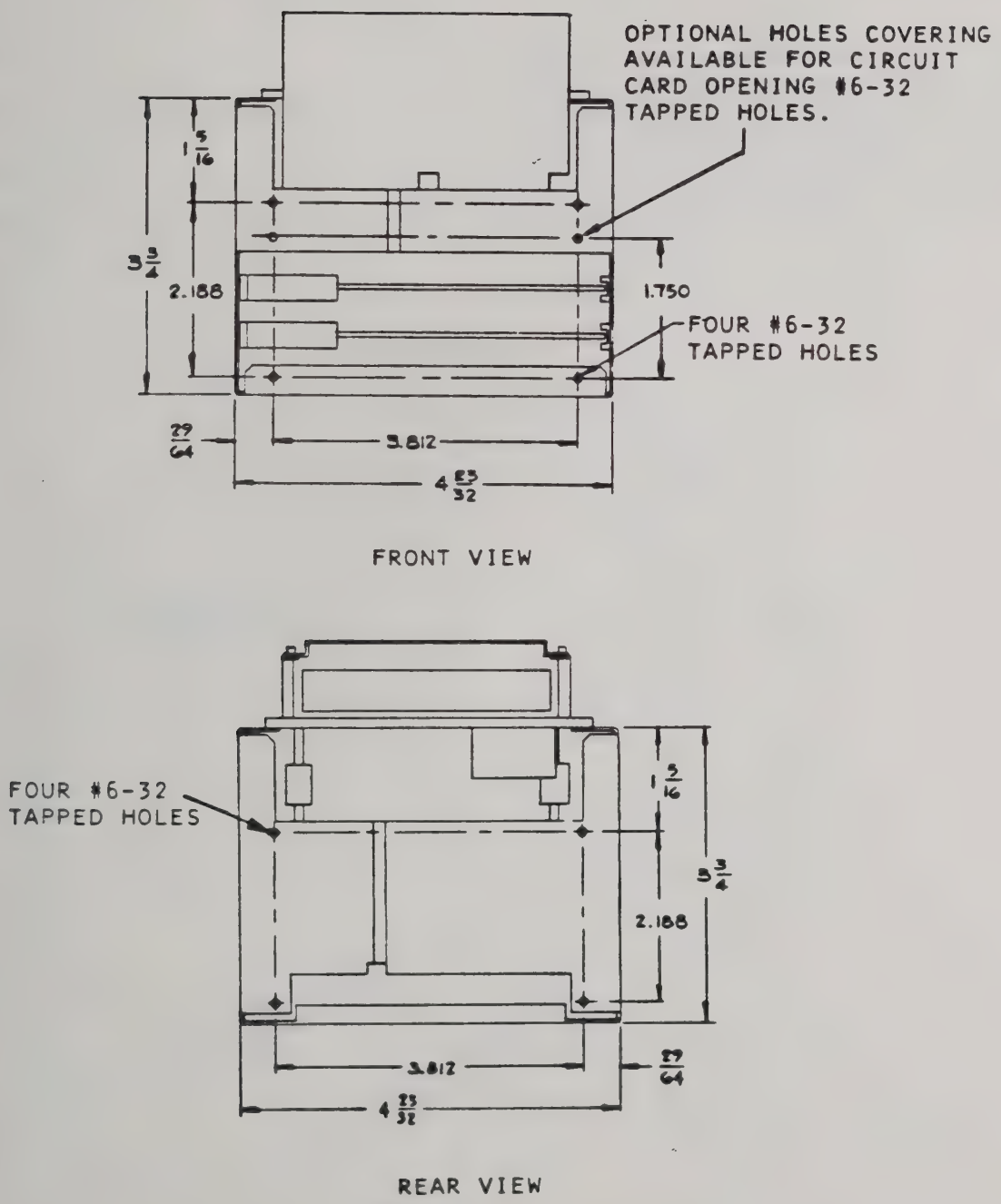


Figure 1-3. Card Cage, Rear Exit Circuit Card (Sheet 2 of 2)

SECTION 2

INSTALLATION AND OPERATION

2.1 GENERAL

This section provides installation instructions for the Model 200.

2.2 UNPACKING

Upon opening the shipping container check that all parts ordered are present and undamaged. If the drive was specified with a card cage, the entire unit will be preassembled and connected according to figure 2-1. If no card cage was specified it will be necessary to plug in ribbon cables as shown in figure 2-2.

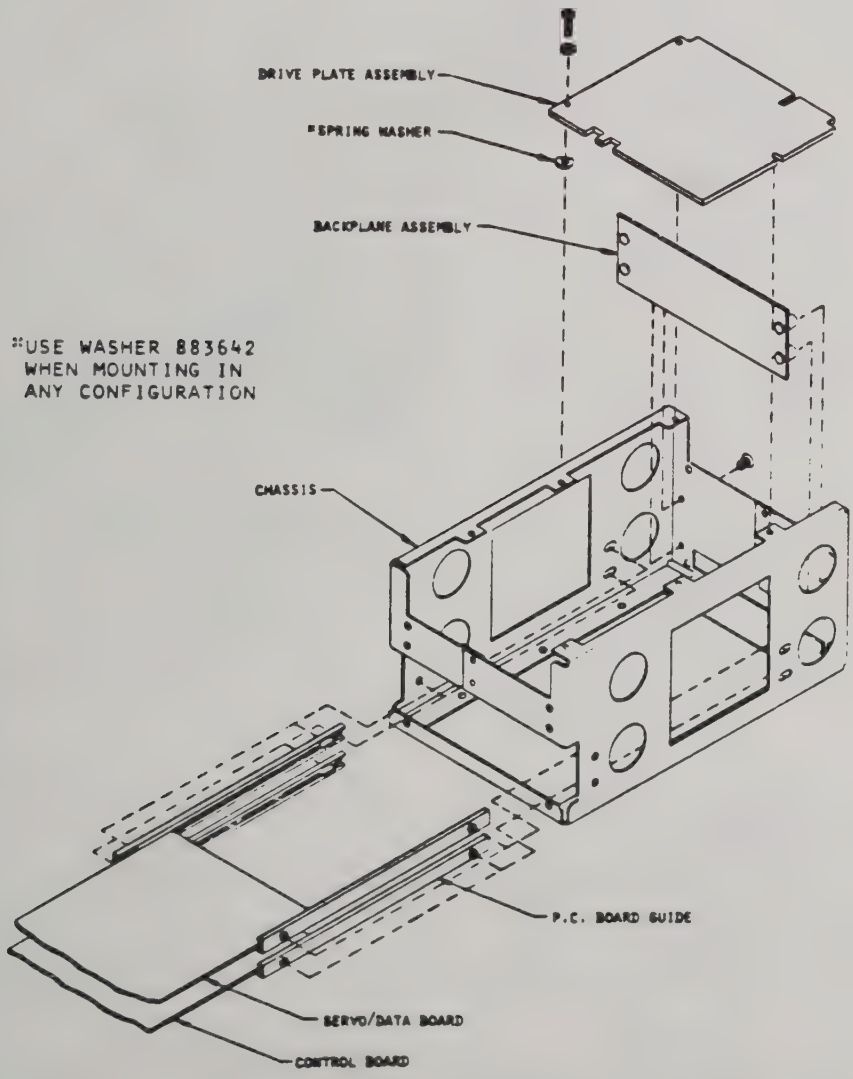
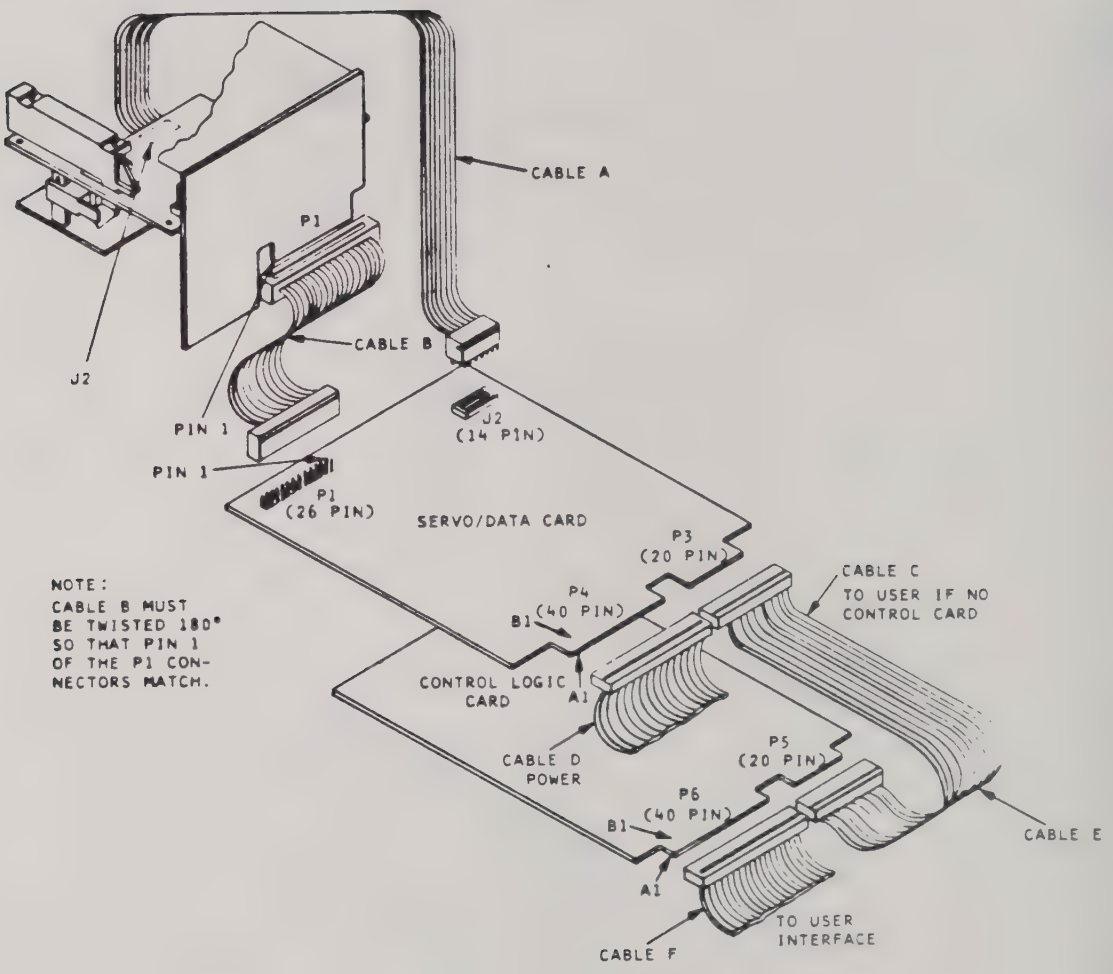


Figure 2-1. Card Cage Installation Drawing



NOTES: Cable set, P/N 786662 (contains cables A and B) connects drive to servo data card (1 ft. max. length).

Cable set, P/N 786663 (contains cables C and D, 2 ft. long) interfaces to a drive which uses a servo data card only.

Cable set, P/N 786664 (contains cables D, E, and F) connects servo data card to control logic card.

When a Backplane and Drive-Card Cage is ordered, cables A and B are required and cables C, D, and F are not required. Order Cable sets, P/N 786662 and 786656.

Mating connector for P4 and P6-3M 3464-0001.

Mating connector for P3 and P5-3M 3461-0001.

Figure 2-2. Model 200 Minidrive, Installation Configuration Drawing

2.3 POWER CONNECTIONS

Power connections must be at least 24 GA wire to J4 of the servo/data card if no card cage is specified. A separate wire must be supplied and commoned at the power supply for each pin called out for power in the connection tables.

2.4 POWER CONNECTIONS (CARD CAGE OR BACKPLANE)

If a card cage is specified, the connections should be 18 GA wire to a 4-pin, Molex P/N 03-06-1042 (housing), Pins 02-06-1103. Power connections are shown in Figure 2-3.

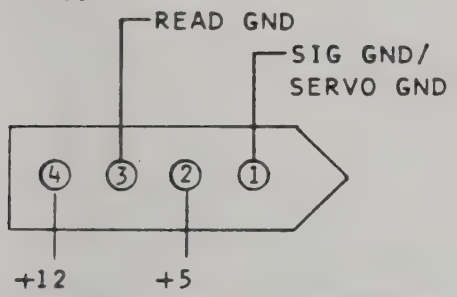


Figure 2-3. Power Connections

2.5 SIGNAL CONNECTIONS (CARD CAGE OR BACKPLANE)

Signal connections should be 28 GA ribbon cable. Connections are the same as in table 1-6 for both card cage and control card. The card cage must use a 40-pin ribbon connector (Ansley P/N 609-4000M). The control card uses a 3M ribbon type card edge connector (3M P/N 3464-0000).

2.6 GROUNDING

When the Model 200 is installed into a customer chassis, the ground lug (fig. 2-4) must be grounded to customer signal ground. In addition, the drive assembly plate must be isolated from customer chassis.

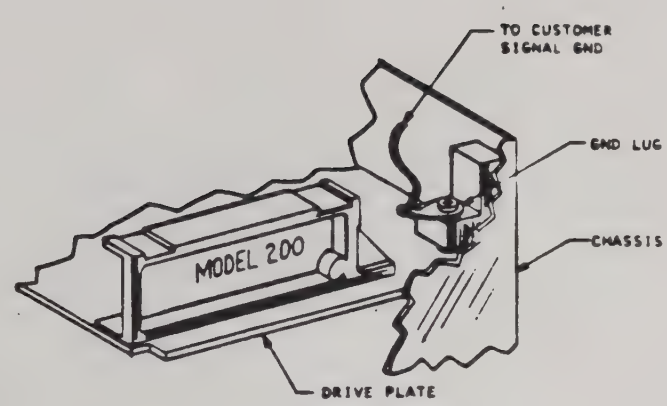


Figure 2-4. Grounding

2.6A CONNECTOR KEYING

Make sure to properly key connectors that plus into J1 of the status drive and to J2 on the read/write card in order not to damage the tape drive. (Refer to figure 2-4A).

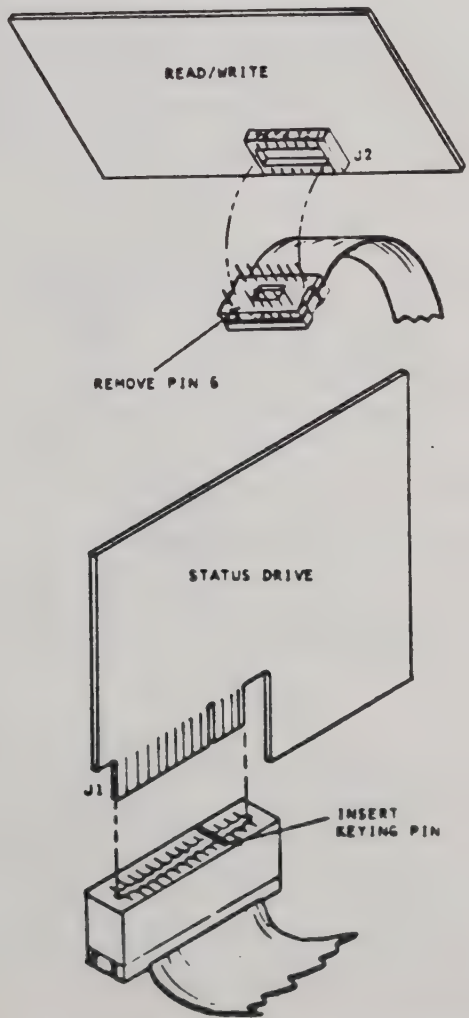


Figure 2-4A. Connector Keying

2.7 COOLING

The Model 200 should not be accelerated or decelerated more than seven times a second. (See figure 2-5.) The drive is designed to operate at constant speed without stopping. This is considered to be a 100% duty cycle and equivalent in power dissipation to the start-stop cycles.

When the Model 200 is operated at 100% duty cycle or at temperatures exceeding 45°C, a minimum of 15 CFM air flow must be provided past the heat sink and exhausted from the enclosure. A positive air pressure must be maintained in the enclosure to prevent dirt and dust from being pulled into the device via the tape cartridge slot opening. Air drawn into the enclosure must be filtered before being pushed past the device. The ratio of air movement to duty cycle is linear.

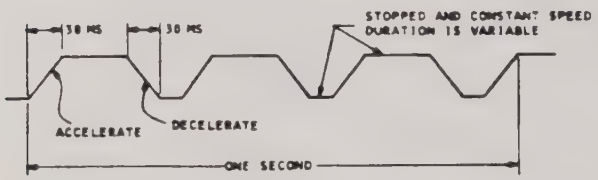


Figure 2-5. Start-Stop Cycle

2.8 INSTALLATION DRAWINGS

See figures 2-1, 2-6, and 2-7 for outline and installation drawings.

CAUTION

In units, with no rev control boards, if Tape Run signal ($\overline{TRC}$) is active while cartridge is being inserted after an unload command was performed, it is possible to wind tape off the end of the reel. TRC should always be disabled when cartridge is not in place. Unit with rev A control boards do not have this restriction.

2.9 MAIN PLATE SPRING WASHERS

When a unit is shipped in a Qantex card cage, three spring washers (fig. 2-1) are mounted between the card cage and the main plate assembly to maintain proper head alignment. When installing a Model 200, make sure to use spring washers, or equivalent.

2.10 CARTRIDGE CARE

2.10.1 Cartridge Loading

The Model 200 is designed to make correct loading easy. To load the cartridge, hold it label-up, line it up with the grooves in the chassis, and slide it in with a firm push. Figure 2-8 illustrates the fit of the cartridge into the drive chassis grooves.

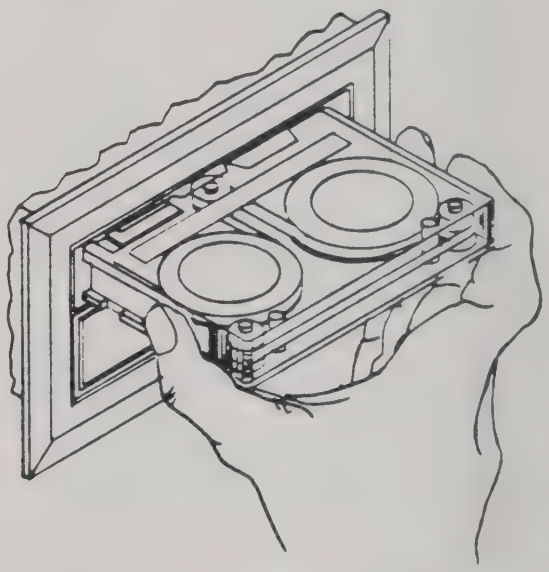


Figure 2-8. Loading a Cartridge

2.10.2 Cartridge Unloading

Unloading the cartridge is as simple as loading. Just push on the eject button and then pull it out. It is best to wait for the tape to stop, before removing the cartridge. The mechanism cannot be damage by removing the cartridge while the tape i moving, but if a write is in progress, dat may be lost. Cartridges should be removed from the drives when the system is not being used to prevent formation of flat spot on the motor drive wheel.

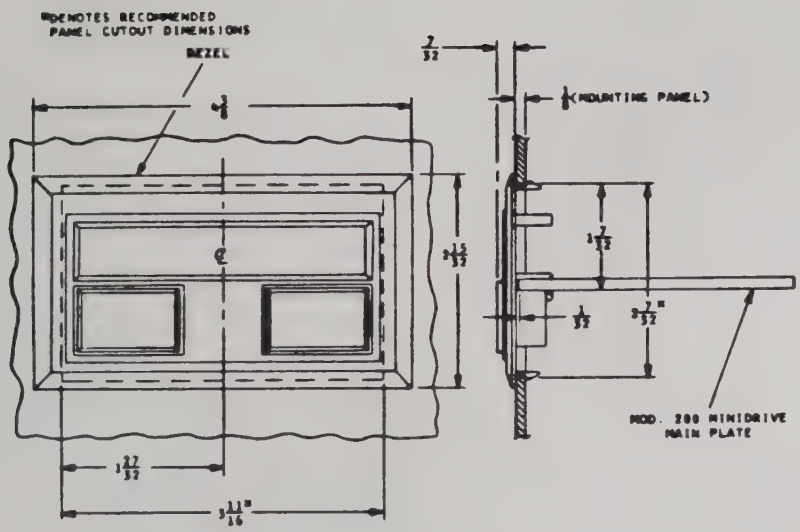


Figure 2-6. Bezel Outline Drawing

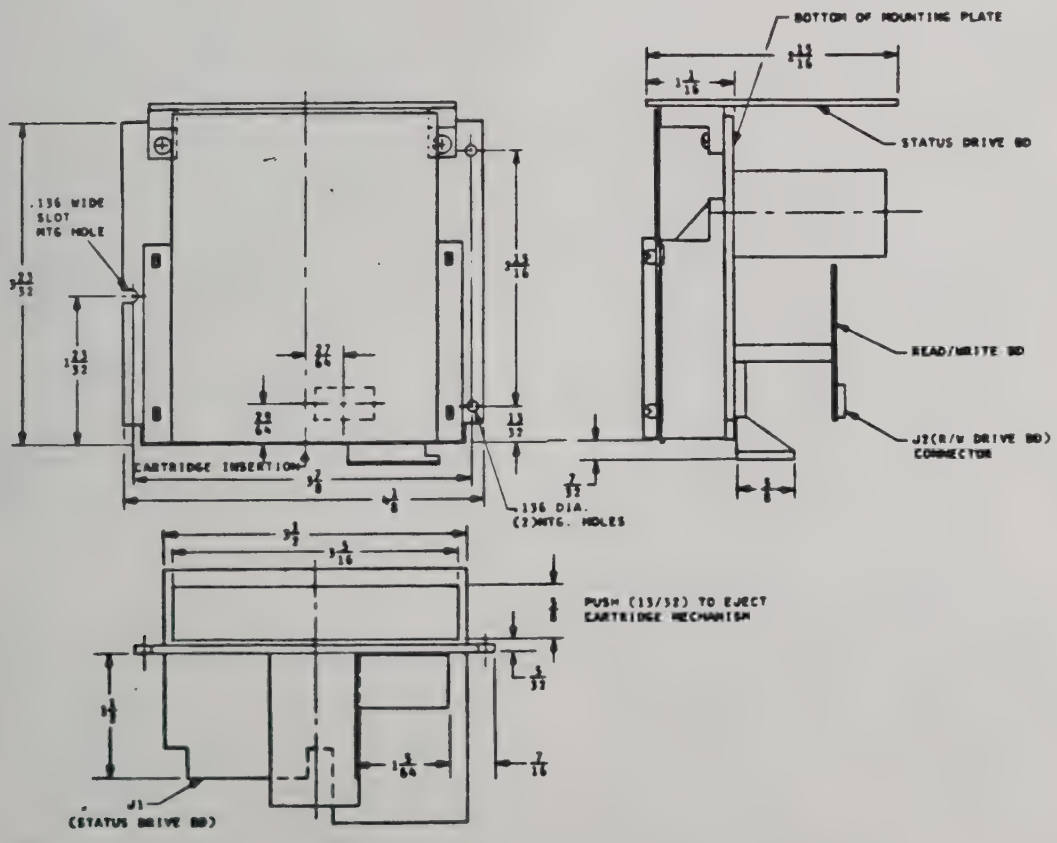


Figure 2-7. Drive Frame Installation Drawing

2.10.3 Write Protect Tab

Each tape cartridge has a movable tab which, when properly positioned, protects data on the tape from unintended write operations. When this Write Protect tab (fig. 2-9) is in the inner position (toward the drive roller), it locks out the write circuitry.

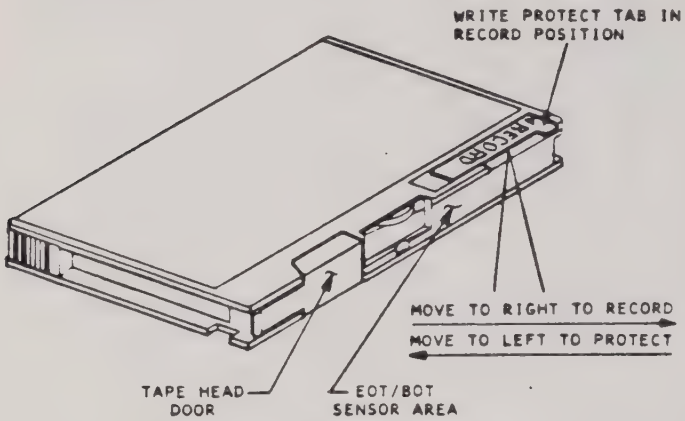


Figure 2-9. Write Protect Tab

When the Write Protect tab is in the outer position, it closes a switch in the chassis and allows the drive to write when it is commanded to. The operator should be sure that system or program tapes are backed up with copies before loading them into the Model 200 with their Write Protect tabs set to record.

The Write Protect tab can be completely removed for long-term write protection. Lift the protect tab with a fingernail under the protruding end. Replace it by dropping it into its slot and pressing on it until it snaps.

2.10.4 Cartridge Storage and Care

Store cartridges in their cases away from dust and heat or direct sunlight. Do not touch the tape; there is no safe way to clean the tape and permanent errors may result. Keep tools and other ferrous or magnetic objects away. If a tape is suspected of having been exposed to environmental extremes as listed in the specifications and if the software operating system permits, wind it all the way through to EOT and back to LP.

2.10.5 Cartridge Wear

Cartridge tape is expected to last for 5000 end-to-end and back passes. If a cartridge is at the end of its life, a read operation may require several retries to get the data in the presence of soft errors. A soft error is a temporary data loss which is usually caused by a speck of dirt or oxide on the tape or head surface. This speck lifts the tape away from head and causes signal loss and consequent read errors. A few extra passes of the tape past the head may knock the speck away and allow error-free reading. If it happens often, the tape is probably old and shedding oxide and should be copied and discarded as soon as possible.

2.10.6 Cartridge Tape Rethreading

Under unusual circumstances of drive failure or cartridge mishandling, the tape might come free of the hub. The tape is not fastened to the hub but is held in place by the elastomer belt and by the tape's wrap around itself. The procedures for looping the tape back onto the hub help the user prevent important data loss, do not substitute for the customary precautions of proper handling and backup copying.

This is a moderately difficult procedure requiring the use of small tools. Minimum tools are a no. 1 Phillips head screwdriver and a small probe (a straightened paper clip can be used). Rethread cartridge tape as follows:

NOTE

Keep magnetized tools away from the bulk of the tape and do not touch the tape surface except at the end because fingerprints cause errors. (If staples or paper clips stick to a tool, it is magnetized.)

a. Open the cartridge by removing the four baseplate Phillips head screws (fig. 2-10) and set it upright on the work

surface with the cover still on.

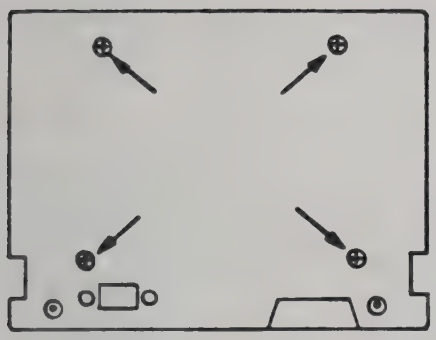


Figure 2-10. Metal Baseplate Screw Locations

b. Lift the cover off.

NOTE

To remove the head gate, swing it out to clear the tape before lifting it up. It is not necessary to remove the head gate to perform this procedure.

c. Thread the end of the tape around the tape guides (fig. 2-11).

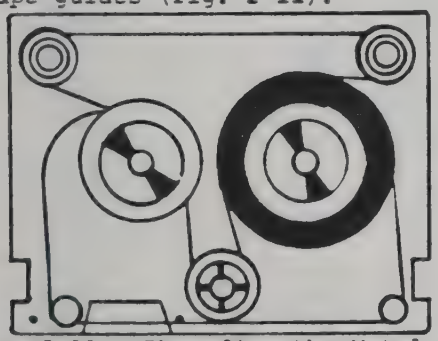


Figure 2-11. Threading the Metal Base Cartridge

d. Moisten the end of the tape with water to get it to stick to the hub.

e. With a small amount of slack at the free end, insert the end between the hub and belt and operate the drive roller with a finger to take up the tape. As soon as the tape is grabbed, keep some back tension on the tape. This will keep it feeding straight into the hub.

f. Continue to wind. Watch for the loose end as it comes around. If it separates from the hub, tuck it under the next turn of tape with the probe. (Back up if the end is too long.)

g. Continue to wind a few more turns with the drive roller while applying tension to the tape.

h. Hold the takeup hub and drive roller fixed, and rotate the supply reel to take up the slack.

i. Continue winding the tape about 20 turns before reassembling. Pay attention to the tape holes and corner rollers so that they do not ride up the shaft and fall off.

j. To reassemble the cartridge, reinstall the gate (if desired) by aligning the long and short ends of the spring with the long and short ends of the gate (fig. 2-12).

k. Drop the spring into the well in the gate. Holding the spring down with a thumbnail or probe, rotate the long end of the spring around to the slot that is at a right angle to the long dimension of the gate. Push the end of the spring into the slot; it should stay there by itself.

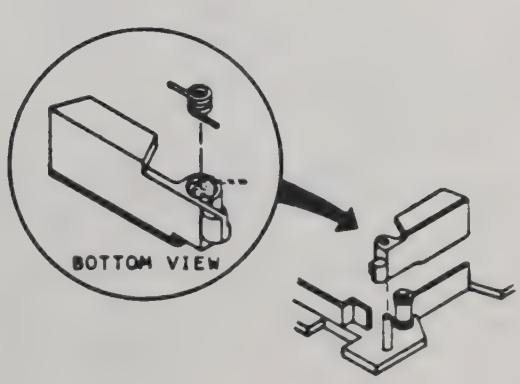


Figure 2-12. Head Gate and Spring

1. Hold the gate halfway out so that the gate and the spring end do not touch the tape. Slowly press the gate down onto its pin on the cartridge baseplate. Reach in with the probe and press the spring down. It will clear its holding slot and snap into position, closing the gate.

m. Carefully lower the cartridge into place and reinstall the screws.

2.11 TERMINATORS AND UNIT SELECTION

2.11.1 Terminators

Up to four Model 200 tape drives can be bussed together, since each tape drive can decode a two bit address. When more than one tape drive is used in a system, only the last tape drive has the terminator inserted (U2, fig. 2-13).

2.11.2 Unit Selection

The control card has provisions to program any address (0, 1, 2, or 3) by placing the jumper in the proper slot of U28 (fig. 2-13). The unit is factory programmed for address 0 (terminals 4 and 13). For this system to operate properly, jumper W1 must be installed.

2.12 ALIGNMENT OF SERVO/DATA CARD

When a loose servo/data card is ordered, the card should be aligned to the Model 200 it is going to be used with according to procedures of paragraphs 4.4.1 and 4.4.2.

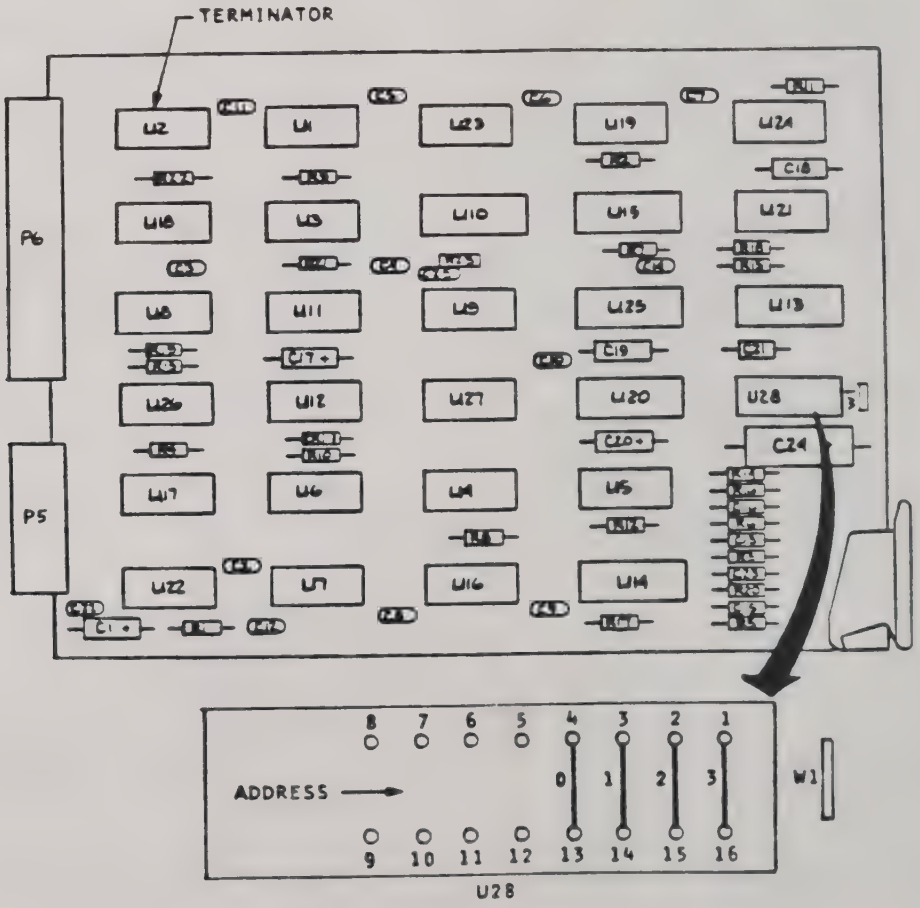


Figure 2-13. Terminator and Unit Selection

SECTION 3

THEORY OF OPERATION

3.1 GENERAL

This section provides theory of operation for the Model 200 Minidrive. For a better understanding of the system, the theory is presented to a block as well as schematic diagram levels.

3.2 CONTROL CARD

The command center of the Model 200 is the control card. When power is first applied to the unit or a cartridge is inserted, the control card goes into rewind (RWD), caused by generating tape reverse (FWD=0) at high tape speed (FAST=1). The signals FWD and FAST are generated by U11 (fig. 7-6).

When the tape, in rewind mode, reaches the beginning of the cartridge, a pair of punched through holes on the tape are detected by a photo-electric sensor as 2 pulses in rapid succession. This pulse pair is used to generate a Beginning-of-Tape signal (BOT). This is accomplished by applying the Tape Mark Sensor (TMS) signal to circuitry shown in figure 7-6. (See timing diagram, fig. 3-1.)

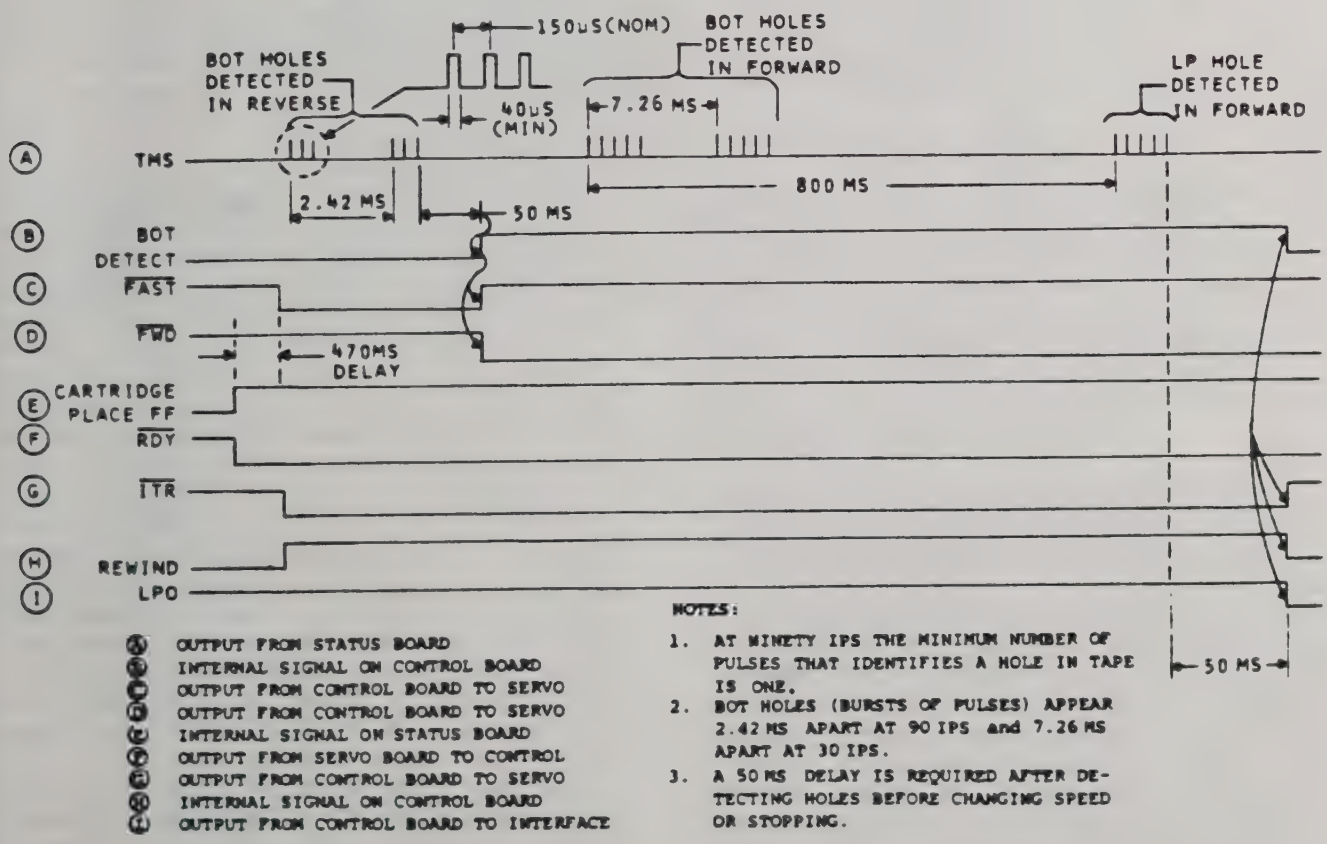

150uS(NOM)
BOT HOLES DETECTED IN FORWARD
BOT HOLES DETECTED IN REVERSE
40uS (MIN)
7.26 MS
LP HOLE DETECTED IN FORWARD
A TMS
800 MS
2.42 MS
50 MS
B BOT DETECT
C FAST
D FWD
470MS DELAY
E CARTRIDGE PLACE FF
F RDY
G ITR
M REWIND
I LPO
50 MS
NOTES:
1. AT NINETY IPS THE MINIMUM NUMBER OF PULSES THAT IDENTIFIES A HOLE IN TAPE IS ONE.
2. BOT HOLES (BURSTS OF PULSES) APPEAR 2.42 MS APART AT 90 IPS and 7.26 MS APART AT 30 IPS.
3. A 50 MS DELAY IS REQUIRED AFTER DETECTING HOLES BEFORE CHANGING SPEED OR STOPPING.
A OUTPUT FROM STATUS BOARD
B INTERNAL SIGNAL ON CONTROL BOARD
C OUTPUT FROM CONTROL BOARD TO SERVO
D OUTPUT FROM CONTROL BOARD TO SERVO
E INTERNAL SIGNAL ON STATUS BOARD
F OUTPUT FROM SERVO BOARD TO CONTROL
G OUTPUT FROM CONTROL BOARD TO SERVO
M INTERNAL SIGNAL ON CONTROL BOARD
I OUTPUT FROM CONTROL BOARD TO INTERFACE

Figure 3-1. Internal Timing For Load Function With Tape Positioned Between BOT and LP Holes

The BOT signal will change the tape direction to forward by asserting FWD. Additionally, the tape speed will be changed to low speed. The tape motion continues until the tape is at Load Point (LP), at which point the transport is stopped by the LP logic on the control card. LP is detected as a pulsed TMS signal. The tape motion stops upon detection of LP by resetting the Internal Tape Run (ITR) signal generated by U21-8 (fig. 7-6).

Once at load point, externally controlled tape motion is possible. Tape may be moved forward at high or low speeds. Reverse tape motion is possible at LP with the exception of a RWD command. A RWD command will not cause any motion to occur. A reverse motion command will default to a rewind condition as soon as the LP hole is detected in reverse.

If the cartridge reaches the end of the tape, another tape hole sequence is detected by the TMS. The first is a one hole TMS signal called Early Warning (EW). EW is simply used as an indication to the user that there is two feet of recording space left before the physical end of tape. The second TMS signal shows that the reel is at End-of-Tape (EOT). This signal is used to stop the tape by resetting ITR. Only reverse tape motion is possible from EOT. (See timing diagram, fig. 3-2.)

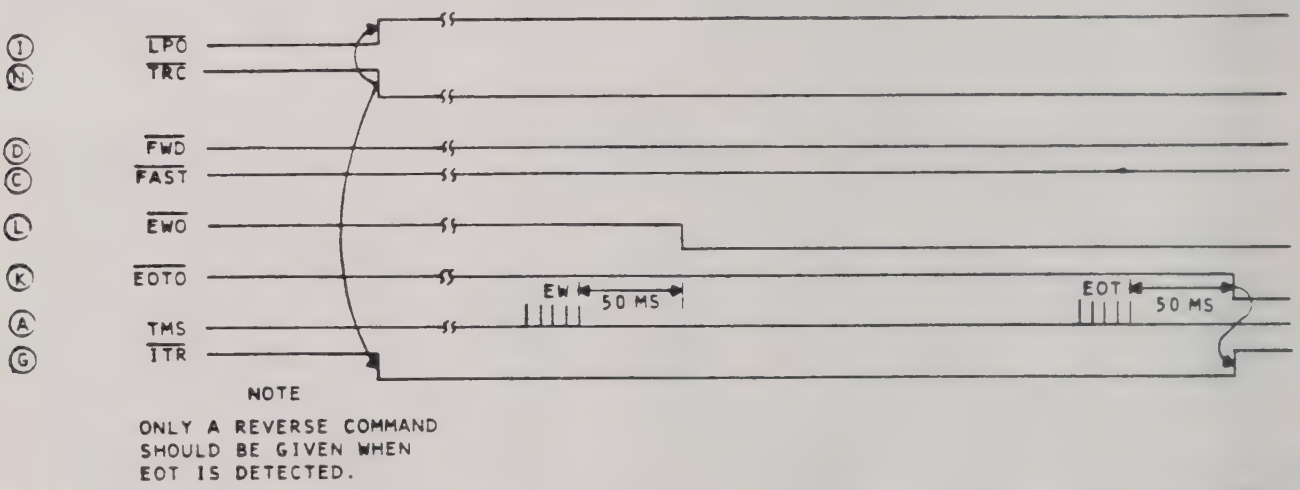


Figure 3-2. Timing for Detection of EW and EOT in Forward

Other control signals are UNLD, SELA and SELB. If UNLD is asserted, the tape is rewound to BOT; ITR is reset stopping the tape, and a signal called Ready is also reset. (See timing diagram, fig. 3-3.) To restore the ready signal it is necessary to manually eject and reinsert the cartridge. The Ready signal is basically used as a general enable control for the transport. Input and output control is only possible if this signal is asserted. During all controlled operations of a particular transport, its unique two bit binary address number must be asserted by having that number on the SELA and SELB lines. Asserting that number, asserts Ready. In addition, a cartridge must be inserted to assert a Ready signal.

3.3 SERVO OPERATION

We know from the previous paragraph that the various operations generate three basic motion control siganls: ITR (Internal Tape Run); FWD (Forward); and FAST. These signals are applied to the servo section of the servo/data card (fig. 7-4). To understand the servo, refer to figures 3-4 and 7-4.

The lower right hand of figure 3-4, shows the slotted disk which is mounted to the motor shaft. This disk is slotted at regular intervals so that when the edge is placed in the light beam detector and the motor is running, the frequency output from the tach is proportional to the angular

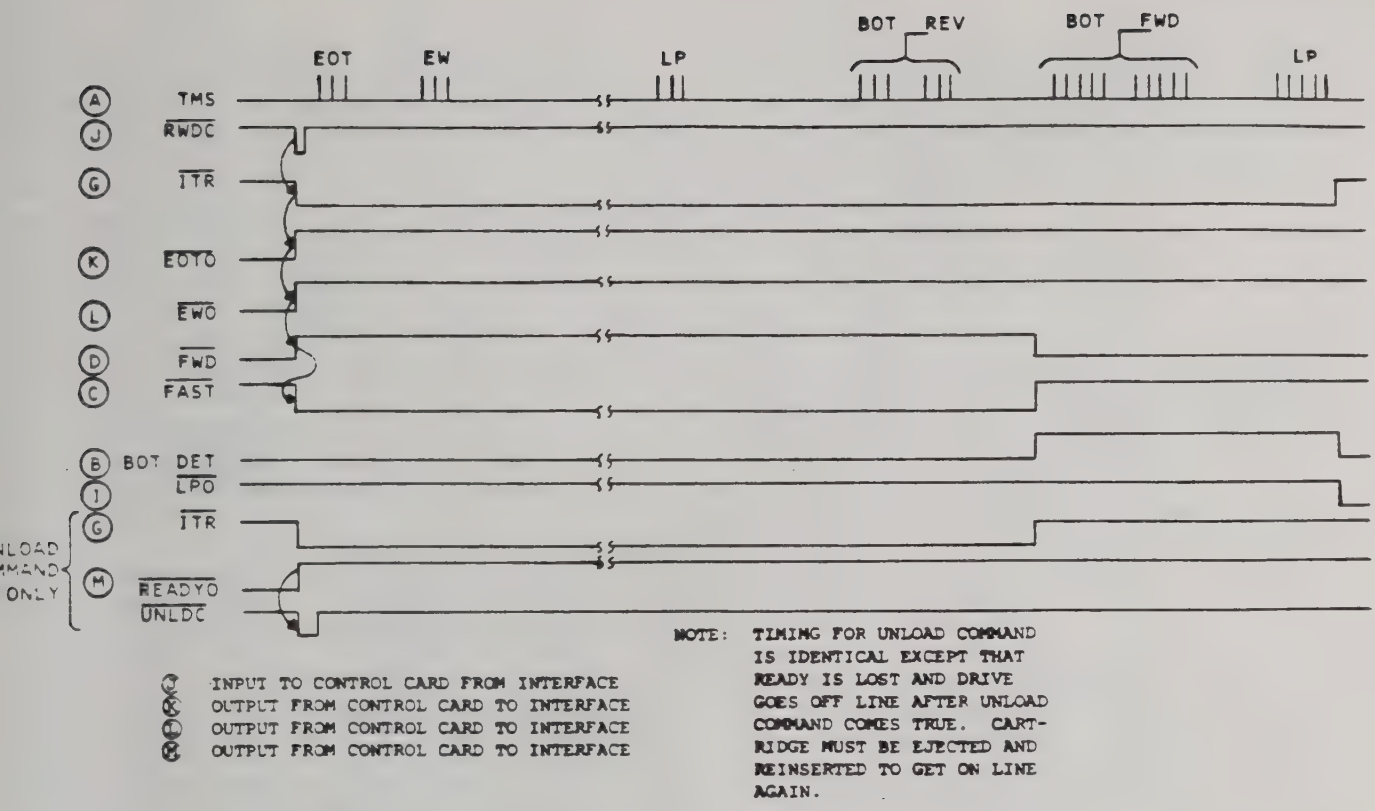


Figure 3-3. Timing for Rewind Command from EOT

velocity of the motor. If the cartridge is running at 30 ips, the tach output is 3.95 kHz. In general, if the servo circuit is set to slow (FAST=1), it will supply voltage to the motor to keep the output of the tach at 3.95 kHz. The electronics will lock the motor to a reference, assuring a highly stable speed. If 90 ips is desired (FAST=0), the frequency (Buffer/divide by 3) will no longer act as a buffer just passing the tach's 3.95 kHz into the servo circuit as it did when set to FAST=1. Instead, this block will divide the tach pulses by 3. The servo circuit, which is designed to look for 3.95 kHz, will therefore have to drive the motor to provide tach pulses at 3 times that frequency. Thus, the servo will always keep the processed sync signal at 3.95 kHz.

The processed sync signal goes into the edge triggered pulse generator, composed basically of two one shots (U3, U11) with their outputs summed by U11. This summation is enabled when Tape Run (TR) is asserted. The top one shot is designed to trigger on the trailing edge of the processed sync signal while the bottom is set to trigger on the leading edge. The pulse width on each one shot is approximately 15 µS, Therefore a pulse train is created where each pulse has a duty cycle of 15 µS with a repetition rate of twice that of the processed sync signal (7.9 kHz).

Any variations in the described 7.9 kHz signal which indicates motor speed error is accounted for making an average dc value proportional to the repetition rate of the 7.9 kHz signal. To extract this dc level from the pulse train, heavy filtering of ac components is necessary. This is accomplished by the pulse repetition-to-dc level converter (Q1, Q2, U14). After passing through various TTL gates, the 7.9 kHz signal goes to a low impedance buffer stage that translates the reference level of the signal. This is accomplished by Q1 and Q2. The buffered signal goes through a low pass filter composed of R42, C13, R43, and C14

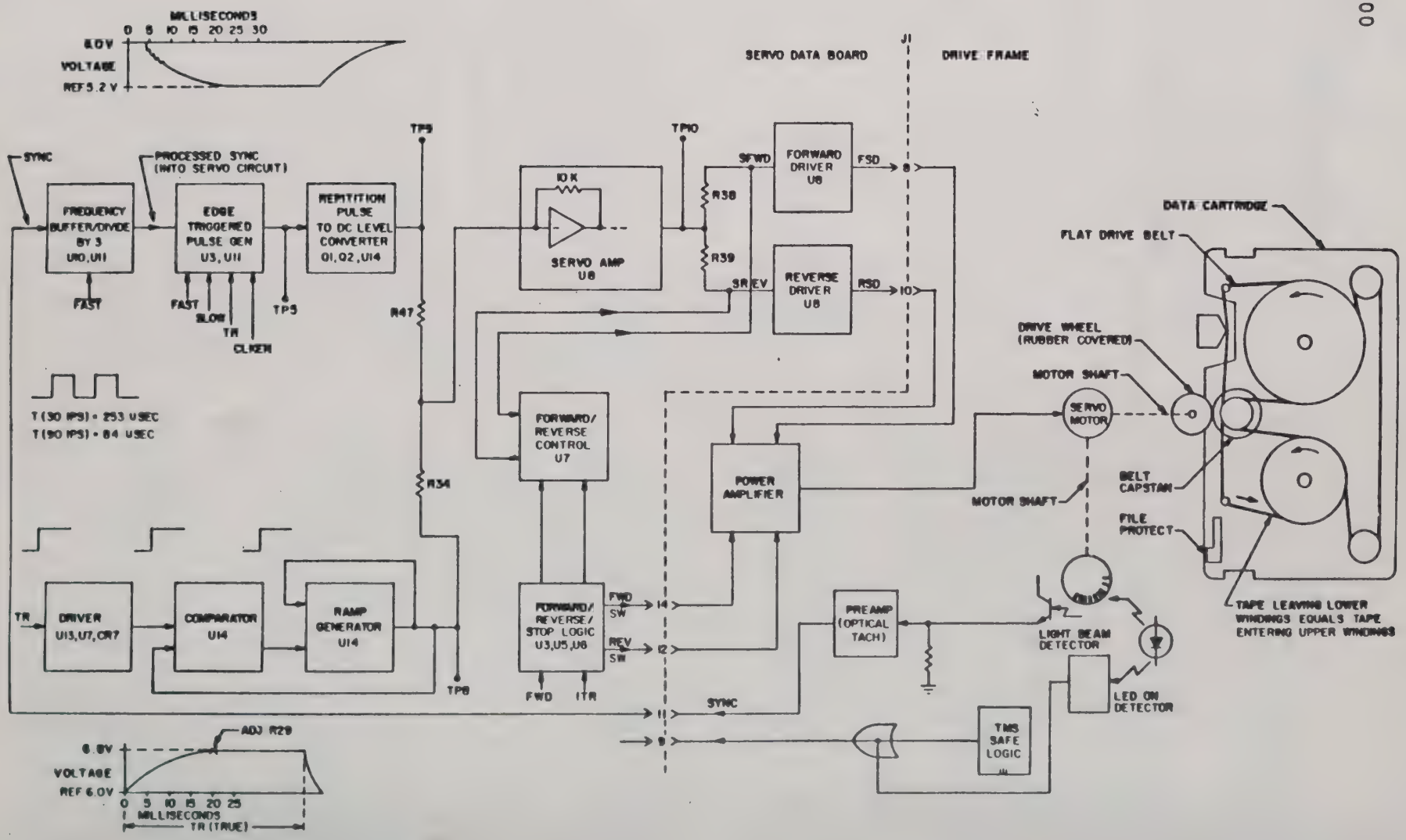


Figure 3-4. Servo System, Block Diagram

which yields the desired dc motor speed signal. This signal is amplified and inverted by U14, and is called the Speed signal which will be referred to later.

The second important part of the servo is the Ramp generator. This is used as the control for the motor speed and acceleration profile. The output of the driver in figure 3-4 is at the amplifier reference level. TR, fed through U13, controls FET switch U7, to enable the servo reference signal. This level is about 0.8 V above the amplifier reference level (6 V or 6.8 V). This servo reference signal is accurately set to provide the correct speed (waveform at this point is a step function). The signal is refined by being resynthesized through a comparator and ramp generator (U14). This establishes the acceleration profile of the servo. Ideally the motor speed signal found at TP9, should be an exact inverted match to the reference signal resynthesized by the ramp generator (TP8). When the motor is up to speed, the dc speed signal should be about 0.8 V below op-amp reference, whereas the reference signal should be about 0.8 V above op-amp reference level. This is because the initial stage of the servo amp (U8) is set up as a summing amplifier and adds the Reference signal to the inverted Speed signal. This new signal is the Error signal (the higher the speed of the motor deviates from the correct level, the higher the value of the Error signal). The Error signal is amplified further through the servo amp and goes to either the forward driver or reverse driver (U8) depending upon the desired direction of tape travel. It then goes to the H configuration power amp used to drive the motor (fig. 7-1).

In addition to the FSD and RSD signals from the forward and reverse drivers respectively, there are the FWD SW and REV SW signals used to ground the correct bottom transistor in the H configuration. These four signals are derived in part from the forward/reverse/stop logic and the forward reverse control (on the servo/data card). These circuits are used not only to control direction, but also to dynamically stop the motor. When ITR is reset, these circuits will reverse the polarity of the motor long enough to bring it to a stop (any longer would cause the tape to move in the opposite direction). The time a reversal signal is applied is controlled by the part of U3 associated with TP4.

3.4 READ/WRITE FUNCTION

Initially, data from the tape is picked up by the two Read windings (fig. 3-5). The track selected is controlled directly by the $\overline{TK1}$/TK2 signal on the track multiplexer (U1). The signal output from the multiplexer goes through a differential amplifier (U2, U3) and filters for band width limiting and is transferred to the servo/data card via another differential amplifier (U15).

The data waveform goes to both a zero cross-over detect circuit (U16) and a threshold detector. The zero cross-over is used to trigger the edge triggered pulse generator whose output is inverted to serve as a clock pulse. The latch (U5) is clocked approximately 1/4 the data time after each zero crossing of the data waveform. The D input of the latch is enabled by the data threshold detector. The threshold level is set to provide moise immunity for reading and writing data. For writing data, the threshold is set to a higher level so that data written on a bad tape will not be detected by the read circuit. This circuit is active only for a dual gap head. The waveforms of the described circuits may be seen on the right of figure 3-5. The output from the D latch, fed by the threshold detector and clocked by the edge triggered pulse generator, is the inverted data output. The timing for retrieval of read information from either a single or dual gap head is shown in figure 3-6.

Writing is accomplished by circuitry on the read/write board. As viewed on the left side of figure 3-5, if writing is desired, the center taps of the two write windings are brought up to a +12 V potential. Grounding the correct terminals on either the TK1 or TK2 windings will cause current to flow in the selected winding, generating

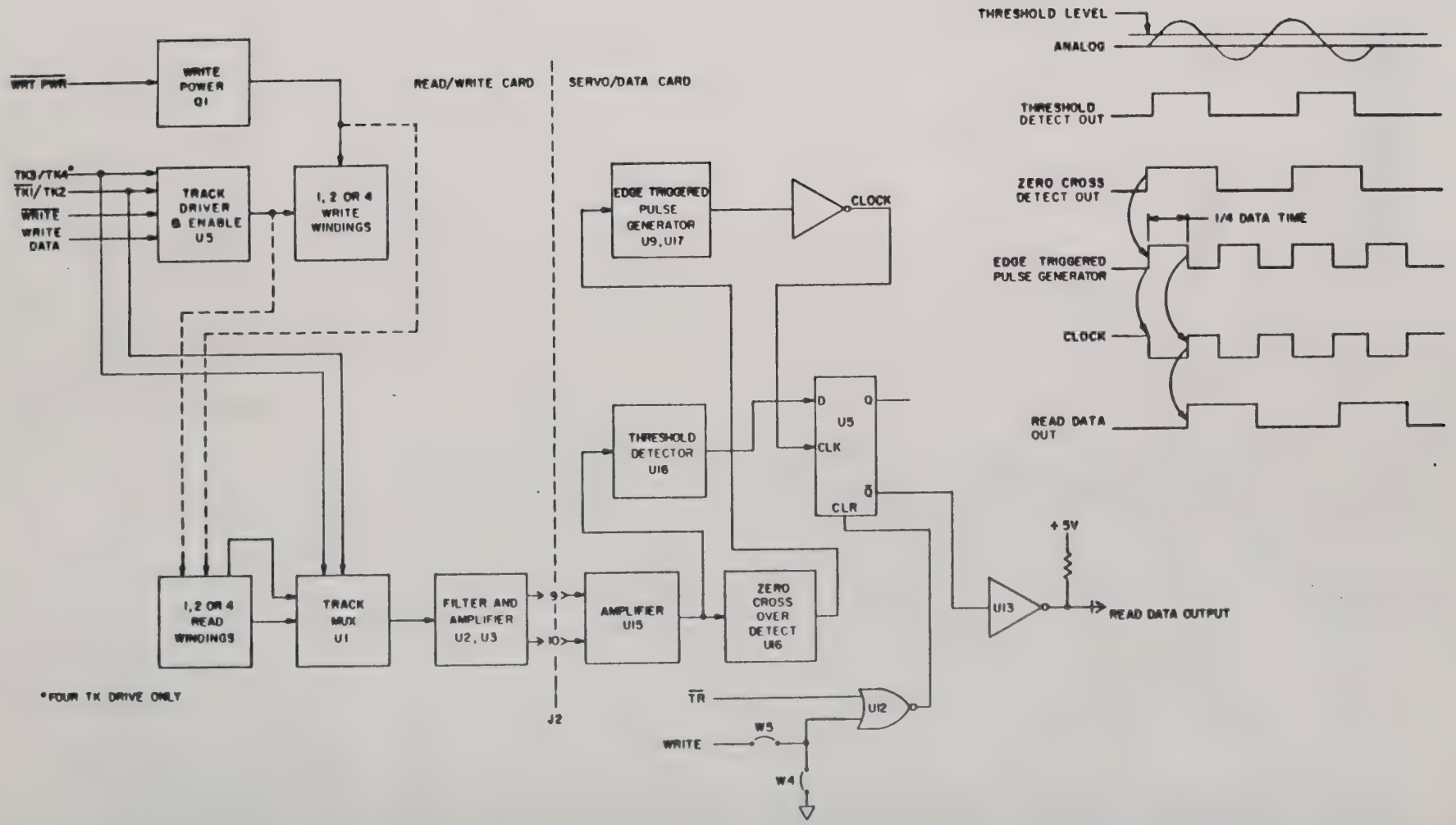


Figure 3-5. Read/Write Circuits, Block Diagram

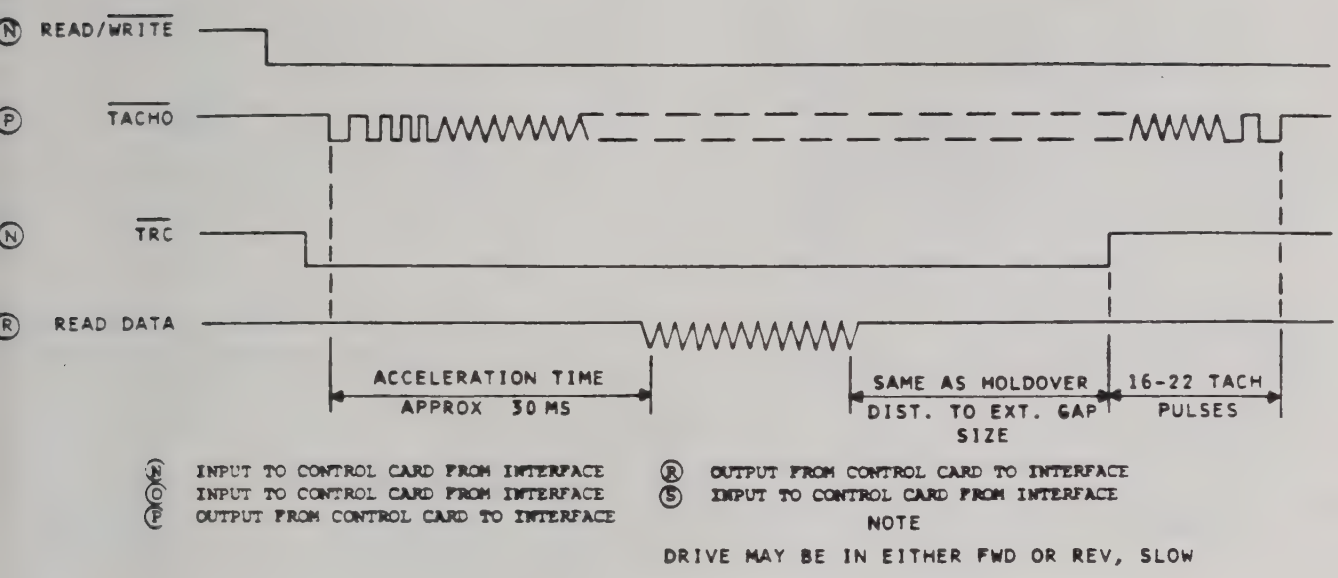


Figure 3-6. Timing for Read Only Dual Gap or Single Gap Head

a flux to either record a 1 or a 0 on the chosen track of the tape. Changing the write data line at the correct frequency will cause pulses to be recorded on tape. The track drive and enable (U5) which is a BCD-to-decimal decoder, will select the proper winding to put current through.

$\overline{\text{WRITE}}$ must be asserted, when writing, to enable U5. To enable the center taps of the windings to +12 V, $\overline{\text{WRITE}}$ PWR must be asserted; this turns on the write power circuitry. The timing for dual gap read-after-write data on tape is shown in figure 3-7.

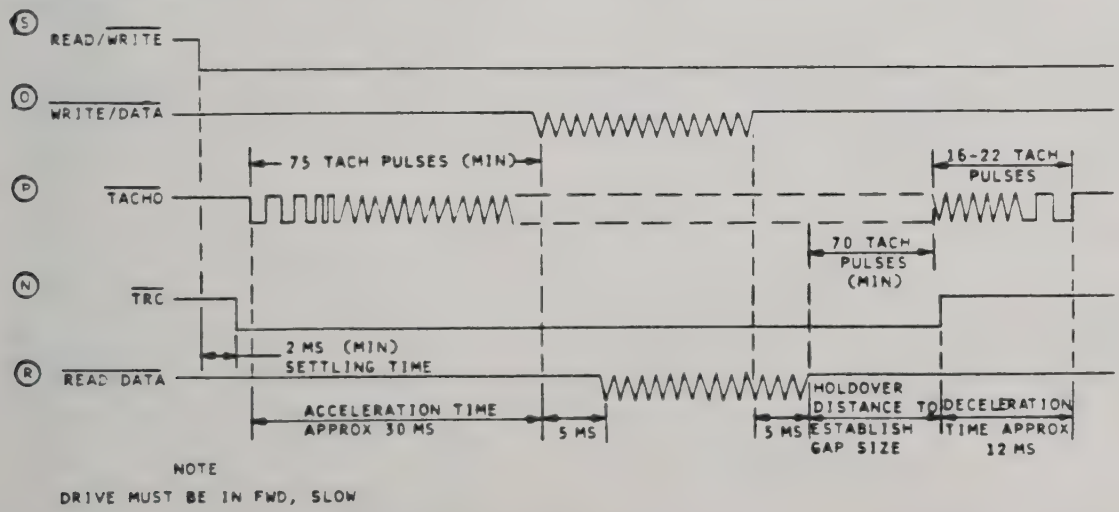


Figure 3-7. Timing or Dual Gap Read-After-Write Head-Writing

The single gap system of reading and writing may be seen by viewing figure 7-2 and is also functionally represented by the broken connector lines on figure 3-5. In this system, the same windings are used for reading and writing, which prevents both of these operations from being done simultaneously. The $\overline{\text{WRITE PWR}}$ and $\overline{\text{WRITE}}$ is therefore not asserted during reading.

During writing, all the Multiplexer switches remain open so that the write voltages do not pass into the read amplifier. Additionally, on the servo/data card, W5 is jumped instead of W4 so that the read circuits are inhibited during writing. The timing for writing data with a single gap head is shown in figure 3-8.

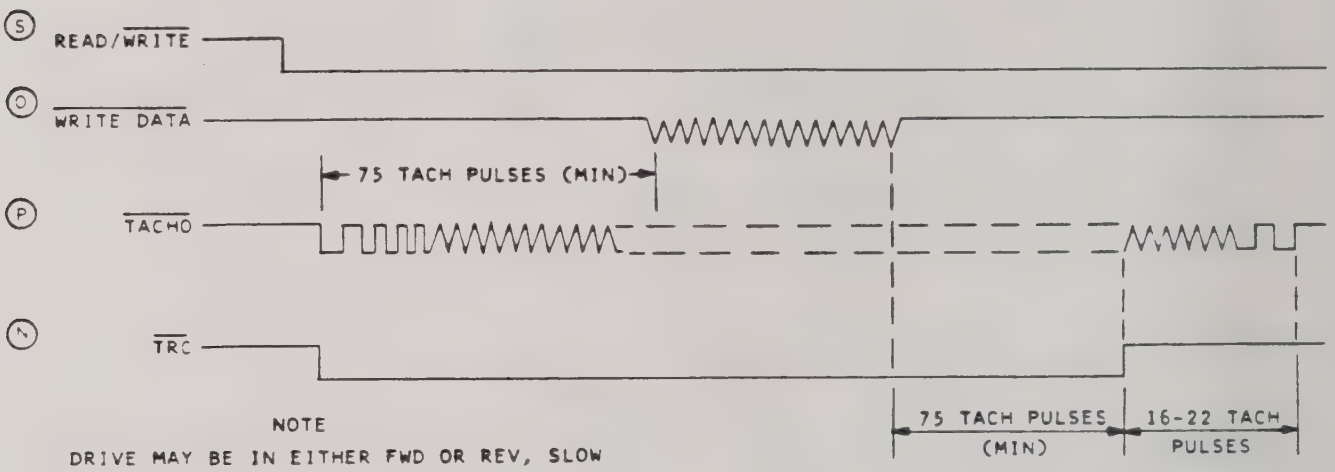


Figure 3-8. Timing for Single Gap Head-Writing

SECTION 4

MAINTENANCE

4.1 GENERAL

This section contains cleaning and adjustment procedures for the Model 200 Minidrive.

4.2 CLEANING

For cleaning intervals of the various assemblies of the Model 200, refer to table 4-1.

Table 4-1. Cleaning Intervals

Unit	Cleaning interval
Tape head	After 8 hours of tape motion
Drive capstan	After 8 hours of tape motion
Tachometer	Monthly
Tape mark sensor	Monthly

4.2.1 Tape Head Cleaning

Tape head and drive capstan should be cleaned at least after every eight hours of tape motion. Isopropyl alcohol or spray of Freon TF must be used for this prupose. Any other solvents may damage the head or capstan. Under no circumstances should the head mounting be moved since this may effect operation. Clean as follows:

CAUTION

Do not use magnetic devices near the tape head. Do not touch the tape head with metal or other hard objects. Doing so may damage the head, resulting in tape cartridge damage and causing loss of data.

a. Inspect the tape head by shining a small light, such as a penlight, at an angle across the head surface. Look for accumulated foreign matter or damage to the head.

b. If the head is dirty, continue with this procedure. However, if the head is damaged or worn, it should be replaced.

c. To clean oxide and accumulated foreign matter from the head surface, use a cotton swab moistened with isopropyl alcohol or a spray of Freon TF. Light oxide accumulations are readily removable. Heavy, or long-term, accumulations may require more cleaning, with more alcohol or Freon TF and clean swabs. Use extreme care when cleaning the head to prevent scratching or damaging the head surface.

d. After removing all accumulated material, use a clean, dry cotton swab to remove residue and polish the head.

4.2.2 Tachometer Cleaning

Visual inspection of the optical tachometer disk should be performed once a month. If the disk shows dirt or fingerprints, it should be cleaned with a soft moist cloth.

If unit has a stainless steel tachometer disk, instead of a nylon disk, it should be cleaned by brushing or blowing air across surface where slots are. Be sure to remove any accumulated dirt or dust from the open areas. Excessive accumulation of dirt will cause speed stability problems.

4.2.3 Tape Mark Sensor Cleaning

Visual inspection of the emitter and sensor on the TMS assembly should be performed monthly. Use a soft brush or Q-tip to clean out any accumulated dust or dirt on the lenses of these devices.

4.3 PACKING TAPES

Tapes should be cycled (wind and rewind) periodically. This packs the tape, to keep the tape tension evenly adjusted and to prevent irregular stacking. This is es-

pecially important if only a portion of the tape is used repeatedly. It is especially important if the tape has been dropped or has undergone a significant temperature change.

4.4 ADJUSTMENTS

The following paragraphs provide adjustment procedures for the Model 200 Minidrive.

4.4.1 Speed Adjustment

Periodic adjustment of the Servo speed is recommended to insure continued compatibility between drives. Proceed as follows:

a. Assert a forward low speed command with a cartridge inserted.

b. Connect a counter to TP5 on the servo/data board.

c. Adjust R29 for a frequency of 7.9 kHz ±2%.

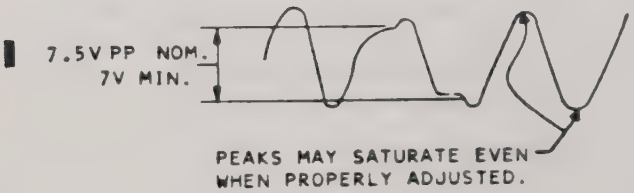
4.4.2 Read Gain Adjustment

Periodic adjustment of the read preamplifier gain is recommended to reliably read low output tapes. Proceed as follows:

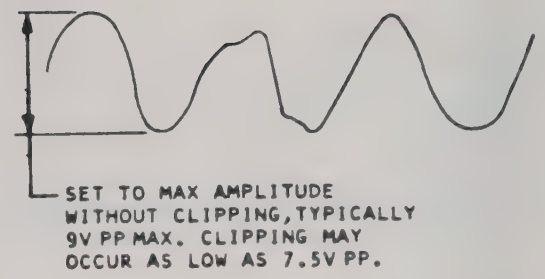
a. Write a continuous 1100 record for the entire length of the tape on track 1.

b. Rewind tape and read the record, just generated, while monitoring U15, pin 6 on the servo/data board with an oscilloscope.

c. For 800 bpi drives, adjust gain with R3 on read/write board per illustration below.



d. For 1600 bpi drives, adjust gain with R3 on read/write board per illustration below.



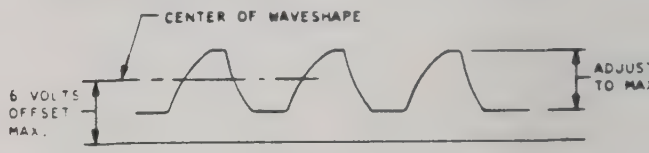
4.4.3 TAPE MARK SENSOR ADJUSTMENT

Aging in the LED and sensor can cause a change in the ability to detect the holes on tape. If this should occur, adjust as follows:

a. Remove the fuse (F1) on the status drive board and insert a cartridge which has the load point hole situated over the mirror.

b. Monitor TP1 on the status drive board with an oscilloscope and rotate the capstan until a maximum peak-to-peak wave shape is observed.

c. Adjust R11 on the status drive board for a maximum peak-to-peak voltage as shown below.



d. Rotate hole away from mirror and verify that maximum peak-to-peak residual is 200 mV. If it is greater than 200 mV, reduce gain using R11 for 200 mV. Check that peak-to-peak output, with hole centered over mirror is at least 1.3 volts.

NOTE

Variations in cartridges will cause a wide spread in this voltage setting. Two hole sizes exist on the DC100A cartridge tape mark holes. The alignments should be performed with a small

hole cartridge and checked with a large hole cartridge. If a large hole cartridge produces a greater than 6 V offset (step c), then the gain should be reduced to a 6 V offset. The peak-to-peak signal should not be below 0.8 V with either cartridge.

e. Remove cartridge and restore fuse.

.5 REMOVAL AND REPLACEMENT

NOTE

The key numbers in parenthesis refer to figure 6-1.

.5.1 Removal of Cover

Remove the cover (1) as follows:

a. Snap cover off cartridge guides (2, 25).

b. Remove cover.

To replace cover, snap back onto top of cartridge guides.

.5.2 Removal of Disc Assembly

Remove the disc assembly (21, 22, 23) as follows:

a. Remove set screw (20) from wheel drive (21).

b. Remove disc assembly. For further disassembly, proceed to step c.

c. Remove screw (24) and retainer disc (23) which secures the disc (22) to the drive wheel (21).

For reassembly, reverse the disassembly procedure.

4.5.3 Removal of Motor

Remove the motor (13) as follows:

a. Remove disc assembly (para. 4.5.2).

b. Disconnect two wires connecting the motor to the status drive (14).

c. Remove three screws and washers (17) securing motor to the plate (1).

d. Remove motor.

To reassemble, reverse the disassembly procedure.

4.5.4 Removal of Read/Write Assembly

Remove the read/write assembly (10 or 11) as follows:

a. Disconnect two screws from motor.

b. Remove two screws and washers (15) securing read/write board to plate (7).

c. Remove read/write board.

To reassemble, reverse disassembly procedure.

4.5.5 Removal of Tape Mark Sensor

Remove tape mark sensor (5) as follows:

a. Disconnect connectors P2 and P3.

b. Remove three nuts (9) which secure TMS to plate.

c. Remove TMS.

To reassemble TMS, reverse disassembly procedure.

SECTION 5

TROUBLESHOOTING

Table 5-1 provides troubleshooting procedures to correct simple problems with the drive. It assumes the presence of a complete Minidrive which includes the drive assembly, servo/data, and control cards.

Table 5-1. Troubleshooting Procedure

Item	Symptom	Check
1	No motion when cartridge is inserted.	a. Check fuse (F1) on status drive. b. Check that Cartridge-in-Place switch (CIP) makes contact with cartridge face. c. Check that oscillator is functioning on status drive (TP4). d. Check motor connections.
2	TMS holes not detected on either forward or reverse motion, causing tape to run off the end.	Check TMS alignment (para. 4.4.3)
3	Servo runs at incorrect very high speed.	Check TP5 on status drive card and TP5 on servo data card for presence of tachometer pulses during motion.
4	No read transitions	Check Read gain adjustment (para. 4.4.2) Check for Write transitions on pins 1,2,3, or 4 on read/write card.
5	No drive select	Check position of select jumper on control card.
6	Inconsistent Status and command response	Check for presence of terminator on control card position E1. If more than one drive is bussed, the terminator belongs in the control card at the end of the bus cable.
7	Read data frequency incorrect	Check drive speed adjustment (para. 4.4.1)

Table 5-1. Troubleshooting Procedure (Continued)

Item	Symptom	Check
8	Read and Write soft errors	Check device speed (para. 4.4.1). Check Read amp gain (para. 4.4.2). Check for dirt on head or capstan. Check for proper termination on Read and Write data lines. Check voltages and grounds for noise. Check cartridge for wear.

CAUTION

Capacitors C16, C17, C18, and C19, on the 4 track read/write card (P/N 786807), may have been removed from the board, prior to shipment. The capacitors are used for write head matching and are not required for all heads. Boards having these capacitors should not be exchanged on drives with boards without capacitors, or vice versa. Inserting the wrong board will cause a mismatch and possible degraded performance.

SECTION 6

REPLACEMENT PARTS LIST

This section contains a vendor code list, replacement parts lists, and parts locator diagrams for the Model 200 Minidrive.

Manufacturers Names and Federal Codes

Mfr. Code	Manufacturers' Name	Address
01121	Allen-Bradley Co.	Milwaukee, WI
01295	Texas Instruments	Dallas, TX
04713	Motorola Semiconductor Products Inc.	Phoenix, AZ
06751	Semcor	Phornix, AZ
06776	Robinson Nugent Inc.	New Albany, IN
07047	Milton Ross Co.	Pike Southampton, PA
07263	Fairchild Semiconductor	Mountain View, CA
07342	North Atlantic Industries, Inc.	Hauppauge, NY
09097	Electronic Enclosures Inc.	El Segundo, CA
11869	Sangamo-Western	Weymouth, MA
12040	National Semiconductor	Danbury, CT
13480	Hughes Electronics Co.	Long Beach, CA
16299	Corning Glass Works	Raleigh, NC
32997	Bourns Inc.	Riverside, CA
56289	Sprague Electric Co.	North Adams, MA
71450	CTS Corp.	Elkhart, IN
71468	ITT Cannon Elect. Inc.	Los Angeles, CA
71590	Centralab	Milwaukee, WI
72982	Erie Technological Labs	Erie PA
73138	Beckman Instruments Inc.	Fullerton, CA
75915	Littlefuse Inc.	Plaines, IL
83125	Nytronics Inc.	Darlington, SC
84171	Arco Electronics	Great Neck, NY
91674	Erie Electric Mfg.	Erie, PA

Replacement Parts List: Model 200 Minidrive Assembly

NOTE

Numbers in Designation column refer to figure 6-1.

Des.	Description	Part No.
	Drive Assembly	786699
7	Main Plate Assembly	786626
2	Cartridge Guide, Left Side	297247
25	Cartridge Guide, Right Side	297248
3	Spring, Cam (2)	296354-1, -2
4	Rod, Cam	297244
6	Spring, Cartridge Elevation	297784
8	Ejector, Cartridge	296258
	Button, Eject	296256
5	Tape Mark Sensor Assembly	786627
11C	Spring, Grounding	296371
	Assy., Arm Pivot	548405
11A	Arm, Pivot	296257
11B	Pin, Pivot	298006
14	Status Drive Assembly	786087
16	Heat Sink	297145
13	Motor, 6 V	883233
12	Shield, Motor	297369
21	Wheel, Drive	296237
	Tape Drive Assembly, (1 Track, Single Gap, 800 BPI)	786674
10	Read/Write Board Assembly	786636
	Tape Head Assembly	548071
19	Magnetic Tape Head	884996
18	Plate, Mounting	297239
	Tape Drive Assembly, (2 Track, Single Gap, 800 BPI)	786675
10	Read/Write Board Assembly	786636
	Tape Head Assembly	548070
19	Magnetic Tape Head	884996
18	Plate, Mounting	297239
	Tape Drive Assembly (1 Track, Single Gap, 1600 BPI)	786678
10	Read/Write Board Assembly	786609
	Tape Head Assembly	548057
19	Magnetic Tape Head	884996
18	Plate, Mounting	297239
	Tape Drive Assembly (2 Track, Single Gap, 1600 BPI)	786679
10	Read/Write Board Assembly	786609
	Tape Head Assembly	548056
19	Magnetic Tape Head	884996
18	Plate, Mounting	297239
	Tape Drive Assembly (1 Track, Dual Gap, 800 BPI)	786676
10	Read/Write Board Assembly	786634
	Tape Head Assembly	548055
19	Magnetic Tape Head	884995
18	Plate, Mounting	297239

Replacement Parts List: Model 200 Minidrive Assembly (Continued)

Des.	Description	Part No.
	Tape Drive Assembly (2 Track, Dual Gap, 800 BPI)	786677
10	Read/Write Board Assembly	786634
	Tape Head Assembly	548054
19	Magnetic Tape Head	884995
18	Plate, Mounting	297239
	Tape Drive Assembly (1 Track, Dual Gap, 1600 BPI)	786680
10	Read/Write Board Assembly	786608
	Tape Head Assembly	548055
19	Magnetic Tape Head	884995
18	Plate, Mounting	297239
	Tape Drive Assembly (2 Track, Dual Gap, 1600 BPI)	786681
10	Read/Write Board Assembly	786608
	Tape Head Assembly	548054
19	Magnetic Tape Head	884995
18	Plate, Mounting	297239
	Tape Drive Assembly (4 Track, Dual Gap)	786802
11	Read/Write Board Assembly	786807
	Tape Head Assembly	548315
19	Magnetic Tape Head	884994
	Plate, Mounting	297239
22	Disc	297388
23	Retainer, Disc	296259
1	Cover	296263
	Servo/Data Assembly, Single Gap, 800 BPI	786660
	Servo/Data Assembly, Single Gap, 1600 BPI	786661
	Servo/Data Assembly, Dual Gap, 800 BPI	786635
	Servo/Data Assembly, Dual Gap, 1600 BPI	786616
	Control Board Assembly	786615

LEGEND

1. COVER
2. CARTRIDGE GUIDE, LEFT SIDE
3. CAM SPRING (2)
4. CAM ROD
5. TAPE MARK SENSOR ASSY.
6. SPRING
7. MAIN PLATE ASSY.
8. EJECTOR CARTRIDGE
10. READ/WRITE DRIVE (2 TRACK)
11. READ/WRITE DRIVE (4 TRACK)
11A. ARM PIVOT ASSY.
11B. PIVOT PIN
11C. SPRING
12. MOTOR SHIELD
13. MOTOR, 6V
14. STATUS DRIVE ASSY.
16. HEATSINK
18. TAPE HEAD ASSY, SINGLE GAP
19. TAPE HEAD ASSY, DUAL GAP
21. WHEEL DRIVE
22. DISC
23. RETAINER, DISC
25. CARTRIDGE GUIDE, RIGHT SIDE

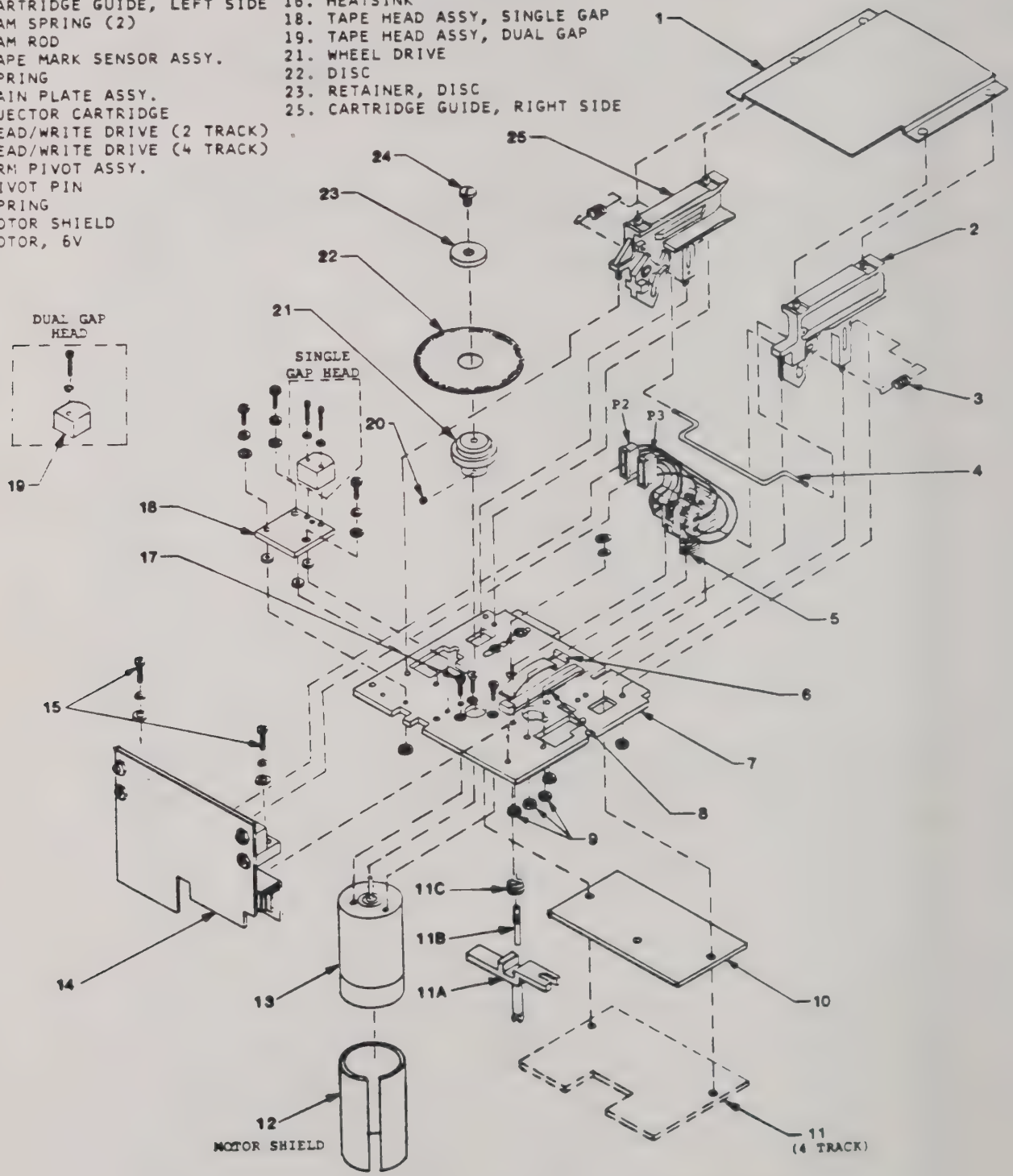


Figure 6-1. Model 200 Minidrive, Exploded View

Replacement Parts List: Status Drive Assembly - 786087

Ref. Des.	Description	Part No.	Code Ident.	Mfr. Part No.	Total Qty
C1	Capacitor, Tantalum 1µf, 35V, ±10%	883882	71468	TAGGA1X0620	1
C2	Capacitor, Tantalum 10µf, 50V, ±10%	801821	56289	109D106X9050C2	1
C3	Capacitor, Ceramic .01µf, 25V, +80-20%	880034	72982	5835-000-Y5U0103Z	5
C4	Same as C3				
C5	Capacitor, Ceramic .018µf, 100V, ±10%	805281	QPL	CK06BX183K	1
C6	Capacitor, Tantalum 1µf, 50V, ±10%	883176	56289	150D105X9050A2	1
C7	Same as C3				
C8	Capacitor, Ceramic .1µf, 12V, ±20%	880636	72982	5655-000-Y5F0104M	2
C9	Same as C3				
C10	Capacitor, Ceramic .1µf, 100V, ±20%	807315	91674	8131-100-651-104M	1
C11	Capacitor, Tantalum 4.7µf, 35V, ±20%	801116	56289	150D475X0035B2	1
C12	Same as C8				
C13	Same as C3				
C14	Capacitor, Ceramic .82µf, 50V, ±10%	805076	QPL	CK06BX824K	1
C15	Capacitor, Ceramic 1000pf, 100V, ±20%	883862	71590	CN20A102K	1
C16	Capacitor, Ceramic 330pf, 500V, ±10%	805221	QPL	CK60AX331K	2
C17	Same as C16				
C18	Capacitor, Ceramic 1.0µF, 50 V , ±20%	807067	91674	8131-050-651-105M	1
CR1	Diode	880052	04713	1N4154	4
CR2	Same as CR1				
CR3	Same as CR1				
CR4	Same as CR1				
F1	Fuse, 1AG, 3 AMP	883178	75915	301003	1
Q2	Transistor	883299	07263	2N2907	1
Q3	Transistor	883174	04713	MJE 801	4
Q4	Same as Q3				
Q5	Same as Q3				

Replacement Parts List: Status Drive Assembly - 786087 (Continued)

Ref. Des.	Description	NAI Part No.	Code Ident.	Mfr. Part No.	Total Qty
Q6	Same as Q3				
Q7	Transistor	880123	07263	2N2392A	2
Q8	Same as Q7				
R1	Resistor, Composition 6.2kΩ, 1/4W, ±5%	880566	01121	CB6225	1
R2	Resistor, Composition 1kΩ, 1/4W, ±5%	880084	01121	CB1025	10
R3	Same as R2				
R4	Resistor, Composition 10kΩ, 1/4W, ±5%	880092	01121	CB1035	3
R5	Resistor, Composition 51kΩ, 1/4W, ±5%	880559	01121	CB5135	1
R6	Same as R4				
R7	Same as R2				
R8	Resistor, Composition 100Ω, 1/4W, ±5%	880077	01121	CB1015	1
R9	Resistor, Composition 680Ω, 1/4W, ±5%	883036	01121	CB6815	1
R10	Same as R2				
R11	Resistor, Variable, 25kΩ	883804	32997	3299W-1-253	1
R12	Resistor, Composition 2.7kΩ, 1/4W, ±5%	880746	01121	CB2725	1
R13	Resistor, Composition 110Ω, 1/4W, ±5%	802229	01121	CB1115	2
R14	Resistor, Composition 100kΩ, 1/4W, ±5%	880846	01121	CB1045	2
R15	Same as R2				
R16	Resistor, Composition 5.6kΩ, 1/4W, ±5%	883022	01121	CB5625	1
R17	Resistor, Composition 150Ω, 1/4W, ±5%	880200	01121	CB1515	1
R18	Same as R13				
R19	Same as R2				
R20	Resistor, Composition 1.8kΩ, 1/4W, ±5%	880642	01121	CB1825	1
R21	Same as R4				
R22	Resistor, Composition 1 MegΩ, 1/4W, ±5%	880100	01121	CB1055	1

Replacement Parts List: Status Drive Assembly - 786087 (Continued)

Ref. Des.	Description	NAI Part No.	Code Ident.	Mfr. Part No.	Total Qty
R23	Same as R2				
R24	Same as R2				
R25	Resistor, Composition 33k , 1/4W, 5%	880097	01121	CB3335	1
R26	Resistor, Composition 43k , 1/4W, 5%	802723	01121	CB4335	1
R27	Same as R2				
R28	Same as R2				
R29	Resistor, Carbon 200 , 1/4W, 5%	880197	01121	CB2015	2
R30	Same as R29				
R31	Resistor, Composition 330 , 1/4W, 5%	880080	01121	CB3315	2
R32	Same as R31				
R33	Same as R14				
U1	Integrated Circuit	807626	12040	LM339	1
U2	Integrated Circuit	883254	12040	DM8544	1
U3	Switch, Optical, Modified	296905	07342	296905	

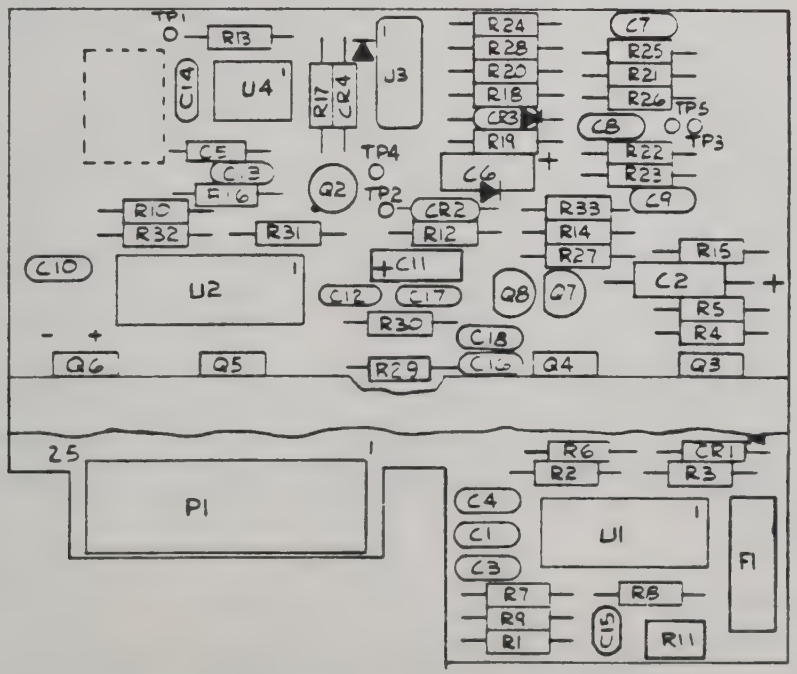


Figure 6-2. Status Drive, Parts Locator

Replacement Parts List: Read/Write Drive Assembly, Single Gap Head (2 Track), 800 BPI - 786636, 1600 BPI - 786609

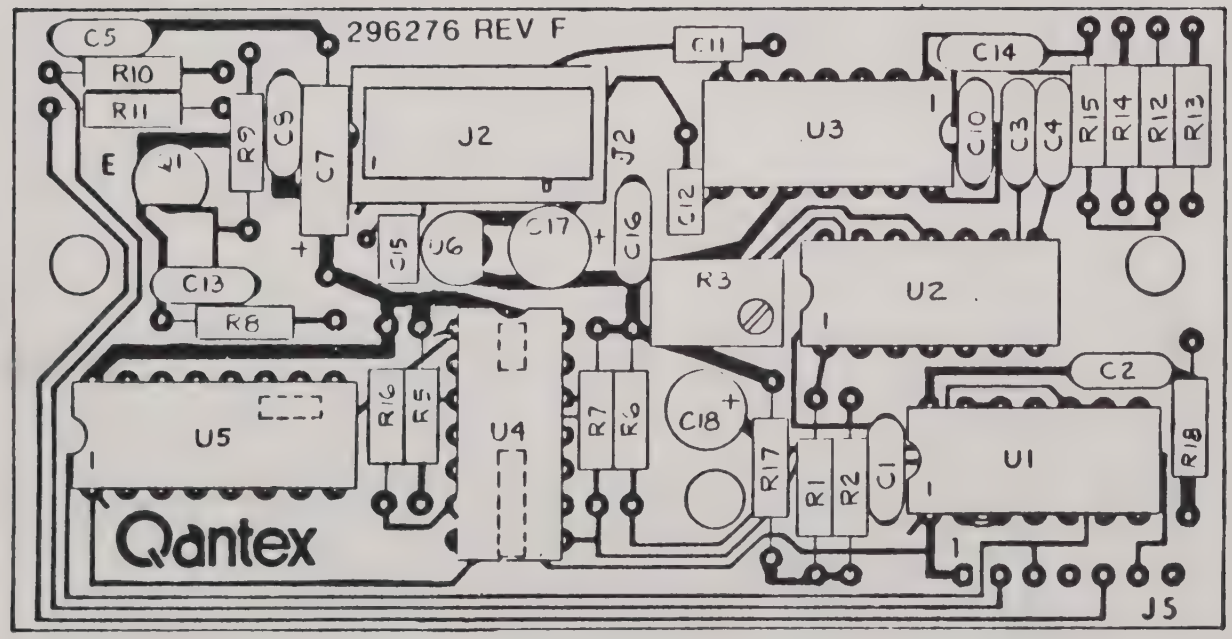
Ref. Des.	Description	NAI P/N	Code Ident.	MFR P/N	Total Qty
C1	Capacitor, Ceramic 10pf,1000V, ±.5pf	880592	72982	831-000C0G0100D	1
C2	Capacitor, Ceramic .01μf, 25V, +80-20%	880034	72982	5835-000Y5U0103Z	5
C3[1]	Capacitor, Ceramic .002μf, 500V, ±20%	888037	72982	CK60AW222M	2
C3[2]	Capacitor, Ceramic .001μf, 1000V, ±20%	806082	QPL	CK60AW102M	2
C4[1]	Same as C3[1]				
C4[2]	Same as C3[2]				
C5	Same as C2				
C7	Capacitor, Tantalum 4.7μf, 10V, ±10%	883476	56289	150D475X9010A2	1
C8	Same as C2				
C10	Same as C2				
C11	Capacitor, Ceramic .47μf, 50V, ±20%	880817	71590	CY20C474M	2
C12	Same as C11				
C13	Same as C2				
C14	Capacitor, Ceramic 300pf, 1000V, ±20%	883181	56289	C023B102E301M	1
C15	Capacitor, Ceramic .033μf, 50V	807291	91674	8121-050-651-333M	1
C16	Capacitor, Ceramic .01μf, 25V, +80-20%	880034	72982	5835-000Y5U0103Z	1
C17	Capacitor, Tantalum 4.7μf, 35V, ±20%	881427	56289	196D475X0035FB	1
C18	Capacitor, Tantalum 10μf, 20V, ±10%	883807	56289	196D106X9020JA1	1
J2	Socket, IC, Lo-Profile	883990	06776	ICN-143-53-G-73	1
Q1	Transistor	880124	07263	2N2907A	1
R1	Resistor, Composition 15kΩ, 1/4W, ±5%	880095	01121	CB1535	2
R2	Same as R1				
R3	Potentiometer, 500Ω	883226	11869	850W-500Ω	1
R5	Resistor, Composition 1kΩ, 1/4W, ±5%	880084	01121	CB1025	3

[1] 800 BPI units only.
[2] 1600 BPI units only.

Replacement Parts List: Read/Write Drive Assembly, Single Gap Head (2 Track), 800 BPI - 786636, 1600 BPI - 786609 (Continued)

Ref. Des.	Description	NAI Part No.	Code Ident.	Mfr. Part No.	Total Qty
R6	Resistor, Composition 10kΩ, 1/4W, ±5%	880092	01121	CB1035	2
R7	Same as R6				
R8	Same as R5				
R9	Resistor, Composition 4.7kΩ, 1/4W, ±5%	880088	01121	CB4725	1
R10[1]	Resistor, Composition 750Ω, 1/4W, ±5%	880602	01121	CB7515	4
R10[2]	Resistor, Composition 910Ω, 1/4W, ±5%	807165	01121	CB9115	2
R11[1]	Same as R10[1]				
R11[2]	Same as R10[2]				
R12[1]	Resistor, Composition 2kΩ, 1/4W, ±5%	880086	01121	CB2025	2
R12[2]	Same as R10[1]				
R13[1]	Same as R12[1]				
R13[2]	Same as R10[1]				
R14[1]	Resistor, Composition 5.1kΩ, 1/4W, ±5%	880089	01121	CB5125	2
R14[2]	Resistor, Composition 1.5kΩ, 1/4W, ±5%	802232	01121	CB1525	2
R15[1]	Same as R14[1]				
R15[2]	Same as R14[2]				
R16	Same as R5				
R17	Resistor, Composition 1kΩ, 1/4W, ±5%	880084	01121	CB1025	2
R18	Same as R17				
U1	Integrated Circuit	883169	12030	CD4016	1
U2	Integrated Circuit	880114	04713	MC1733CL	2
U3	Same as U2				
U4	Integrated Circuit	880336	12040	7416N	1
U5	Integrated Circuit	882060	07263	SN7445N	1
U6	Voltage Regulator	883730	07263	μA78L09AWC	1

[1] 800 BPI units only.
[2] 1600 BPI units only.



CAUTION: PRIOR TO MAINTENANCE OF U1 (CD4016): THE OPERATOR, PRINTED CIRCUIT BOARD AND U1 SHOULD BE GROUNDED.

Figure 6-3. Read/Write Single Gap Head (2 Track), Parts Locator

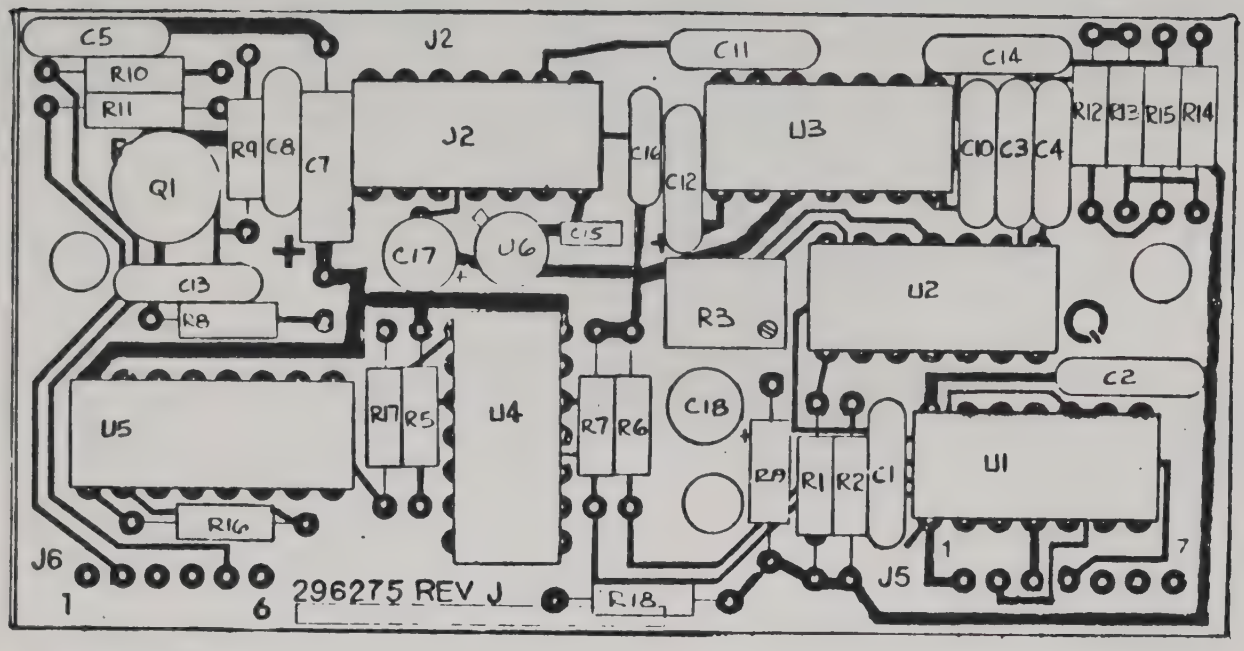
Replacement Parts List: Read/Write Drive Assembly, Dual Gap Head (2 Track), 800 BPI - 786634, 1600 BPI - 786608

Ref. Des.	Description	NAI Part No.	Code Ident.	Mfr. Part No.	Total Qty
C1	Capacitor, Ceramic 10pf, 1000V, ±.5pf	880592	72982	831-000C0G0100D	1
C2	Capacitor, Ceramic .01µf, 25V, +80-20%	880034	72982	5835-000-Y5U0103Z	6
C3[1]	Capacitor, Ceramic .002µf, 500V, ±20%	880037	72982	CK60AW222M	2
C3[2]	Capacitor, Ceramic .001µf, 1000V, ±20%	806082	QPL	CK60AW102M	2
C4[1]	Same as C3[1]				
C4[2]	Same as C3[2]				
C5	Same as C2				
C7	Capacitor, Tantalum 4.7µf, 10V, ±10%	883476	56289	150D475X9010A2	1
C8	Same as C2				
C10	Same as C2				
C11	Capacitor, Ceramic .47µf, 50V, ±20%	880817	71590	CY20C474M	2
C12	Same as C11				
C13	Same as C2				
C14	Capacitor, Ceramic 300pf, 1000V, ±20%	883181	56289	C023B102E301M	1
C15	Capacitor, Ceramic .033µf, 50V	807291	91674	8121-050-651-333W	1
C16	Same as C2				
C17	Capacitor, Tantalum 4.7µf, 35V, ±20%	881427	56289	196D475X0035FB	1
C18	Capacitor, Tantalum 10µf, 20V, ±10%	883807	56289	196D106X9020JA1	1
J2	Socket, IC, Lo-Profile	883990	06776	ICN-143-53-G-73	1
Q1	Transistor	880124	07263	2N2907A	1
R1	Resistor, Composition 15kΩ, 1/4W, ±5%	880095	01121	CB1535	2
R2	Same as R1				
R3	Potentiometer, 500Ω	883226	11869	850W-500Ω	1
R5	Resistor, Composition 1kΩ, 1/4W, ±5%	880084	01121	CB1025	3
R6	Resistor, Composition 10kΩ, 1/4W, ±5%	880092	01121	CB1035	2

[1] 800 BPI units only.
[2] 1600 BPI units only.

Replacement Parts List: Read/Write Drive Assembly, Dual Gap Head (2 Track), 800 BPI - 786634, 1600 BPI - 786608

Ref. Des.	Description	NAI Part No.	Code Ident.	Mfr. Part No.	Total Qty
R7	Same as R6				
R8	Same as R5				
R9	Resistor, Composition 4.7kΩ, 1/4W, ±5%	880088	01121	CB4725	1
R10[1]	Resistor, Composition 750Ω, 1/4W, ±5%	880602	01121	CB7515	2
R10[2]	Resistor, Composition 910Ω, 1/4W, ±5%	807165	01121	CB9115	2
R11[1]	Same as R10[1]				
R11[2]	Same as R10[2]				
R12[1]	Resistor, Composition 2kΩ, 1/4W, ±5%	880086	01121	CB2025	4
R12[2]	Same as R10[1]				
R13[1]	Same as R12[1]				
R13[2]	Same as R10[1]				
R14	Resistor, Composition 5.1kΩ, 1/4W, ±5%	880089	01121	CB5125	2
R15	Same as R14				
R16	Same as R12[1]				
R17	Same as R12[1]				
R18	Same as R5				
R19	Same as R5				
U1	Integrated Circuit	883169	12040	CD4016	1
U2	Integrated Circuit	880114	04713	MC1733CL	2
U3	Same as U2				
U4	Integrated Circuit	880336	12040	7416N	1
U5	Integratee Circuit	882060	07263	SN7445N	1
U6	Voltage Regulator	883730	07263	μA78L09AWC	1



CAUTION: PRIOR TO MAINTENANCE OF U1 (CD4016): THE OPERATOR, PRINTED CIRCUIT BOARD AND U1 SHOULD BE GROUNDED.

Figure 6-4. Read/Write Dual Gap Head (2 Track), Parts Locator

Replacement Parts List: Read/Write Drive Assembly, Dual Gap Head (4 Track) - 786807

Ref. Des.	Description	NAI Part No.	Code Ident.	Mfr. Part No.	Total Qty
C1	Capacitor, Ceramic 10pf, 1000V, ±.5pf	880592	72982	831-000C0G0100D	1
C2	Capacitor, Ceramic .01μf, 25V, +80-20%	880034	72982	5835-000Y5U0103Z	5
C3	Capacitor, Ceramic .001μf, 1000V, ±20%	806082	72982	CK60AW102M	2
C4	Same as C3				
C5	Same as C2				
C6	Capacitor, Tantalum 4.7μf, 35V, ±20%	801116	56289	150D475X0035B2	1
C7	Capacitor, Tantalum 4.7μf, 10V, ±10%	883476	56289	150D475X9010A2	1
C8	Same as C2				
C9	Capacitor, Ceramic .1μf, 12V, ±20%	880636	72982	5655-000-Y5F0104M	1
C10	Same as C2				
C11	Capacitor, Ceramic .47μf, 50V, ±20%	880817	71590	CY20C474M	2
C12	Same as C11				
C13	Same as C2				
C14	Capacitor, Ceramic 300pf, 1000V, ±20%	883181	56289	C023B102E301M	1
C16	Capacitor, Ceramic .0033μF, 500V, ±10%	884191	71590	CW15C332K	1
C17	Same as C16				
C18	Same as C16				
C19	Same as C16				
J2	Socket, IC, Lo-Profile	883990	06776	ICN-143-53-G-73	1
Q1	Transistor	880124	07263	2N2907A	1
R1	Resistor, Composition 15kΩ, 1/4W, ±5%	880095	01121	CB1535	2
R2	Same as R1				
R3	Potentiometer, 500Ω	883226	11869	850W-500Ω	1
R4	Resistor, Ceramic 1.5kΩ, 1/4W, ±5%	802232	01121	CB1525	2
R5	Resistor, Composition 750Ω, 1/4W, ±5%	880602	01121	CB7515	2

Replacement Parts List: Read/Write Drive Assembly, Dual Gap Head (4 Track) - 786807 (Continued)

Ref. Des.	Description	NAI Part No.	Code Ident.	Mfr. Part No.	Total Qty
R6	Same as R5				
R7	Same as R4				
R8	Resistor, Composition 1kΩ, 1/4W, ±5%	880084	01121	CB1025	2
R9	Resistor, Composition 4.7kΩ, 1/4W, ±5%	880088	01121	CB4725	1
R10	Resistor, Composition 10kΩ, 1/4W, ±5%	880092	01121	CB1035	4
R11	Same as R10				
R12	Same as R10				
R13	Same as R10				
R14	Resistor, Composition 470Ω, 1/4W, ±5%	806382	QPL	RCR07G471JP	1
R15	Same as R8				
U1	Integrated Circuit	883169	12040	CD4016	2
U2	Integrated Circuit	880114	04713	MC1733CL	2
U3	Same as U2				
U4	Integrated Circuit	880336	12040	7416N	1
U5	Integrated Circuit	883859	01295	SN75453BP-00	4
U6	Same as U1				
U7	Integrated Circuit	880652	01295	SN74LS139	1
U8	IC, Resistor Network 510Ω	883720	73138	785-1-R510	1
U9	Same as U5				
U10	Same as U5				
U11	Same as U5				

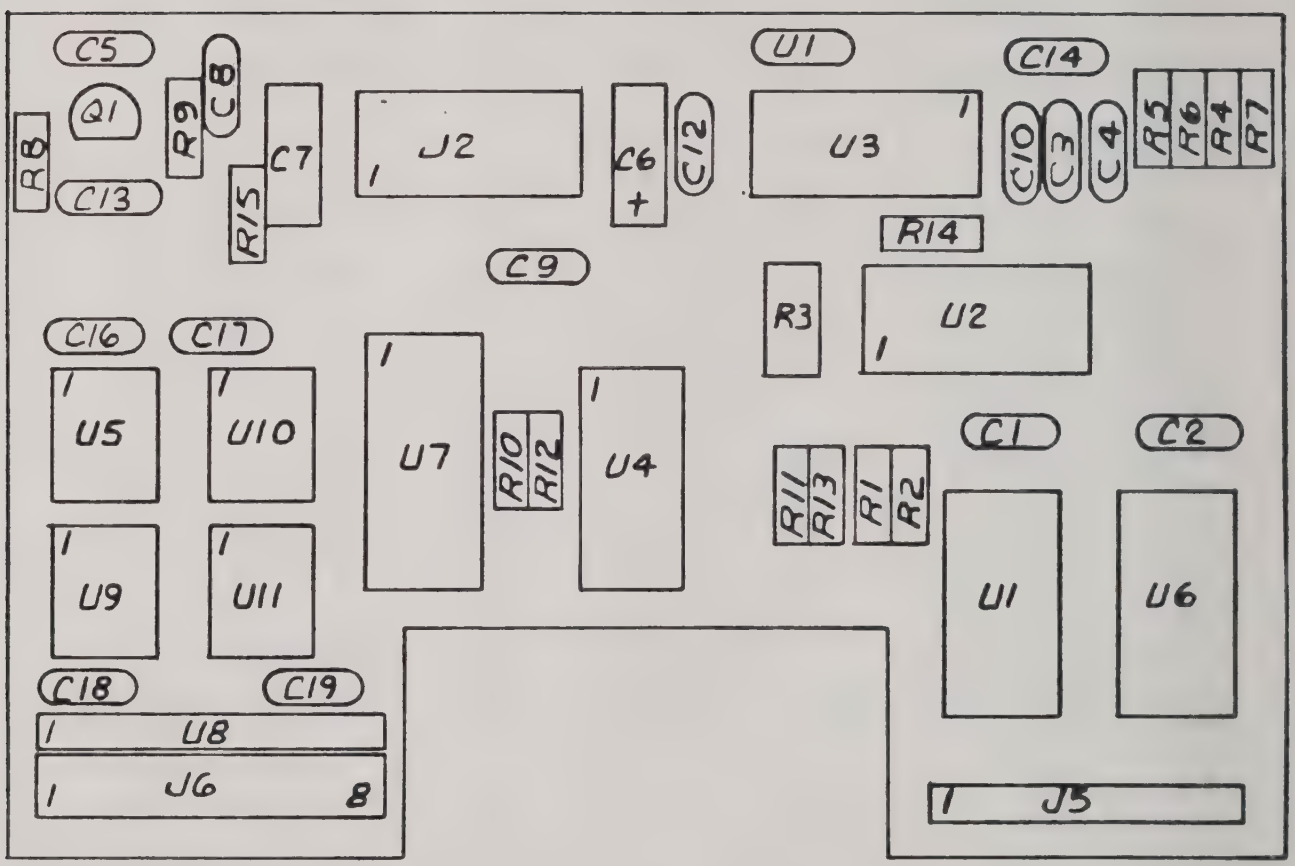


Figure 6-5. Read/Write Dual Gap Head (4 Track), Parts Locator

Replacement Parts List: Servo/Data Assemblies -
786635, 786660 (800 BPI), 786616, 786661 (1600 BPI)

Ref. Des.	Description	NAI Part No.	Code Ident.	Mfr. Part No.	Total Qty
C1	Capacitor, Ceramic 2700pf, 1000V	808533	84171	CCD272G	1
C2	Capacitor, Ceramic .01µf, 25V, +80-20%	880034	72982	5835-000Y5U0103Z	26
C3	Capacitor, Tantalum 2.2µf, 20V, ±20%	880518	56289	150D225X0020A2	1
C4	Capacitor, Ceramic .0015µf, 50V, ±10%	883302	71590	CW15C152K	2
C5	Same as C4				
C6	Same as C2				
C7	Capacitor, Ceramic .18µf, 12V, ±20%	884528	56289	3CX7R184X9100C5	1
C9	Same as C2				
C10	Same as C2				
C11	Same as C2				
C12	Capacitor, Ceramic .033µf, 50V	807291	91674	8121-050-651-333M	1
C13	Capacitor, Ceramic .1µf, 12V, ±20%	880636	72982	5655-000Y5F0104M	1
C14	Same as C2				
C15	Same as C2				
C16	Capacitor, Ceramic 500pf, 500V, ±10%	880710	72982	831-000X5F0501K	1
C17	Capacitor, Tantalum 4.7µf, 50V, ±10%	803944	56289	150D-475X9050R	3
C18	Capacitor, Ceramic 33pf, 500V, ±5%	806719	72982	831-000-U2J0330J	1
C19	Same as C2				
C20	Capacitor, Ceramic 150pf, 1000V, ±10%	806883	72982	831-000X5F0151K	1
C21	Same as C2				
C22	Capacitor, Ceramic .47µf, 50V, ±20%	880817	71590	CY20C474M	1
C23	Capacitor, Ceramic .001µf, 500V, ±10%	883079	72982	801-000X5F0102K	4
C24	Same as C2				
C25	Same as C2				

Replacement Parts List: Servo/Data Assemblies -
786635, 786660 (800 BPI), 786616, 786661 (1600 BPI) (Continued)

Ref. Des.	Description	NAI Part No.	Code Ident.	Mfr. Part No.	Total Qty
C26[1]	Capacitor, Ceramic .0012µf, 200V, ±10%	803991	QPL	CK06CW122K	2
C26[2]	Capacitor, Ceramic 560pf, 100V, ±10%	884148	71590	CW15A561K	2
C27[1]	Same as C26[1]				
C27[2]	Same as C26[2]				
C28	Capacitor, Tantalum 47µf, 10V	883393	71468	47M10	1
C29	Same as C2				
C30	Same as C2				
C31	Same as C17				
C32	Same as C17				
C33	Capacitor, Aluminum 200µf, 15V	883577	84171	ME6E200	1
C34	Same as C2				
C35	Same as C2				
C36	Same as C2				
C37	Same as C2				
C38	Same as C2				
C39	Same as C2				
C40	Same as C2				
C41	Same as C2				
C42	Same as C23				
C43	Same as C2				
C44	Same as C2				
C45	Same as C2				
C46	Same as C23				
C47	Same as C2				
C48	Same as C23				
C49	Same as C2				
C50	Capacitor, Ceramic .047µf, 50V, ±20%	807298	72982	8121-050-651-473M	2
C51	Same as C50				
CR1	Diode	880052	04713	1N4154	4
CR2	Same as CR1				
CR3	Same as CR1				

[1] 800 BPI units only.
[2] 1600 BPI units only.

Replacement Parts List: Servo/Data Assemblies -
786635, 786660 (800 BPI), 786616, 786661 (1600 BPI) (Continued)

Ref. Des.	Description	NAI Part No.	Code Ident.	Mfr. Part No.	Total Qty
CR4	Same as CR1				
CR6	Diode, Zener	806548	04713	1N5233B	1
J4	Socket, IC, 14-pin	883990	06776	ICN-143-53-G-73	1
L1	Choke, 100 µh	883475	83125	WEE-100	1
Q1	Transistor	880715	04713	2N2222	1
Q2	Transistor	880124	07263	2N2907A	1
R1	Resistor, Composition 10kΩ, 1/4W, ±5%	880092	01121	CB1035	17
R2	Resistor, Composition 4.7kΩ, 1/4W, ±5%	880088	01121	CB4725	4
R3	Same as R1				
R4	Same as R1				
R5	Resistor, Composition 2.4kΩ, 1/4W, ±5%	880087	01121	CB2425	6
R6	Same as R5				
R7	Same as R5				
R8	Same as R5				
R9	Same as R5				
R10	Same as R5				
R11	Resistor, Composition 1kΩ, 1/4W, ±5%	880084	01121	CB1025	8
R12	Same as R11				
R13	Resistor, Composition 1.8kΩ, 1/4W, ±5%	880642	01121	CB1825	1
R14	Same as R2				
R15	Same as R1				
R16	Resistor, Composition 9.1kΩ, 1/4W, ±5%	801008	01121	CB9125	2
R17	Same as R2				
R18	Same as R16				
R19	Same as R1				
R20	Resistor, Composition 5.1kΩ, 1/4W, ±5%	880089	01121	CB5125	7
R21	Same as R20				

Replacement Parts List: Servo/Data Assemblies -
786635, 786660 (800 BPI), 786616, 786661 (1600 BPI) (Continued)

Ref. Des.	Description	NAI Part No.	Code Ident.	Mfr. Part No.	Total Qty
R22	Same as R11				
R23	Resistor, Composition 680Ω, 1/4W, ±5%	802187	01121	CB6815	1
R24	Same as R1				
R25	Same as R11				
R27	Same as R1				
R28	Resistor, Composition 6.8kΩ, 1/4W, ±5%	806655	16299	C4, 6.8KΩ	1
R29	Resistor, Variable 20kΩ, Cermet Pot.	883392	32997	3299W-1-203	1
R30	Resistor, Composition 20kΩ, 1/4W, ±5%	880096	01121	CB2035	3
R31	Resistor, Composition 1.5MΩ, 1/4W, ±5%	880599	01121	CB1555	1
R32	Resistor, Metal Film 301kΩ, 1/4W, ±2%	880597	16299	C4, 301KΩ	1
R33	Resistor, Metal Film 47kΩ, 1/4W, ±2%	883247	16299	C4, 47KΩ	1
R34	Resistor, Metal Film 1kΩ, 1/4W, ±1%	880054	16299	NA55-1KΩ	2
R35	Resistor, Composition 22kΩ, 1/4W, ±5%	880368	01121	CB2235	2
R36	Same as R1				
R37	Same as R35				
R38	Resistor, Composition 51kΩ, 1/4W, ±5%	880559	01121	CB5135	3
R39	Same as R38				
R40	Same as R11				
R41	Same as R1				
R42	Resistor, Metal Film 10kΩ, 1/4W, ±2%	880596	16299	C4, 10KΩ	3
R43	Same as R42				
R44	Same as R42				
R45	Resistor, Metal Film 56kΩ, 1/8W, ±1%	806551	16299	NC4, 56KΩ	1
R46	Same as R1				
R47	Same as R34				

Replacement Parts List: Servo/Data Assemblies -
786635, 786660 (800 BPI), 786616, 786661 (1600 BPI) (Continued)

Ref. Des.	Description	NAI Part No.	Code Ident.	Mfr. Part No.	Total Qty
R48	Same as R38				
R49	Same as R20				
R50	Same as R11				
R51	Same as R11				
R52	Same as R20				
R53	Same as R1				
R54	Resistor, Composition 1.2kΩ, 1/4W, ±5%	880085	01121	CB1225	1
R55	Same as R20				
R56	Resistor, Composition 510kΩ, 1/4W, ±5%	880099	01121	CB5145	2
R57	Resistor, Composition 510Ω, 1/4W, ±5%	880082	01121	CB5115	2
R58	Same as R30				
R59	Same as R1				
R60	Resistor, Composition 100kΩ, 1/4W, ±5%	801986	01121	CB1045	1
R61	Resistor, Composition 39kΩ, 1/4W, ±5%	802081	01121	CB3935	1
R62	Resistor, Composition 7.5kΩ, 1/4W, ±5%	880557	01121	CB7525	1
R63	Same as R20				
R64	Same as R20				
R65	Same as R56				
R66	Same as R57				
R67	Same as R30				
R68	Same as R1				
R69	Same as R1				
R70	Resistor, Metal Film 3.3kΩ, 1/4W, ±2%	806819	QPL	RL075332G	;
R71	Resistor, Composition 110Ω, 1/2W, ±5%	801145	01121	EB1115	1
R72	Same as R11				
R75	Same as R1				

Replacement Parts List: Servo/Data Assemblies - 786635, 786660 (800 BPI), 786616, 786661 (1600 BPI) (Continued)

Ref. Des.	Description	NAI Part No.	Code Ident.	Mfr. Part No.	Total Qty
R76	Same as R2				
R77	Same as R1				
R78	Same as R1				
U1	Integrated Circuit	880057	01295	7404N	1
U2	Integrated Circuit	808137	01295	SN74LS00N	1
U3	Integrated Circuit	883861	12040	NE556N	2
U4	Integrated Circuit	808341	01295	SN74LS04N	2
U5	Integrated Circuit	883240	01295	SN74LS74N	1
U6	Integrated Circuit	880651	01295	SN7426N	1
U7	Integrated Circuit	883169	12040	CD4016CN	2
U8	Integrated Circuit	883245	12040	LM324N	2
U9	Integrated Circuit	808127	01295	SN74LS32N	1
U10	Integrated Circuit	883243	01295	SN74LS161N	1
U11	Integrated Circuit	883496	01295	SN74LS51N	1
U12	Same as U4				
U13	Integrated Circuit	880140	01295	SN7417N	1
U14	Same as U8				
U15	Integrated Circuit	880024	04713	LM301AN	1
U16	Integrated Circuit	883244	12040	LM319N	1
U17	Same as U3				
U18	Voltage Regulator	883730	07263	µA78L09AWC	1
U19	Same as U7				
U20	Integrated Circuit	883241	01295	SN74LS123N	1

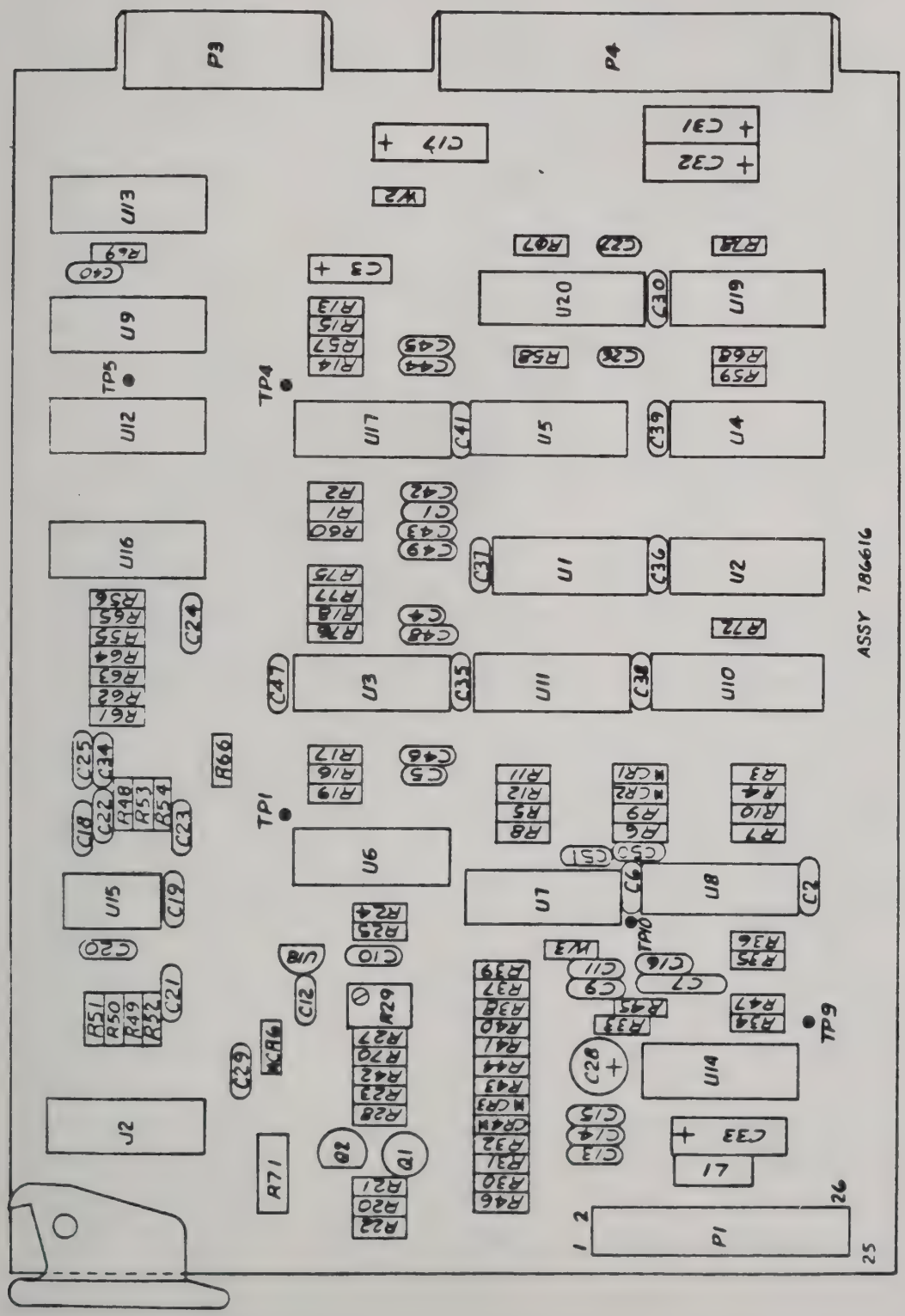


Figure 6-6. Servo/Data Board, Parts Locator

Replacement Parts List: Control Card Assembly - 786615

Ref. Des.	Description	NAI Part No.	Code Ident.	Mfr. Part No.	Total Qty
C1	Capacitor, Tantalum 4.7µf, 10V, ±20%	880072	06751	TS1K-10-475	2
C2	Capacitor, Ceramic .01µf, 25V, +80-20%	880034	72982	5835-000-Y5U0103Z	12
C3	Same as C2				
C4	Same as C2				
C5	Same as C2				
C6	Same as C2				
C7	Same as C2				
C8	Same as C2				
C9	Same as C2				
C10	Same as C2				
C11	Same as C2				
C12	Same as C2				
C13	Capacitor, Film .0015µf, 200V, ±5%	802318	56289	192P15252	5
C14	Capacitor, Ceramic .001µf, 500V, ±10%	883079	72982	801-000-X5F0102K	2
C15	Same as C13				
C16	Same as C13				
C17	Capacitor, Tantalum 10µf, 20V, ±20%	880073	06751	TS2K-20-106	2
C18	Capacitor, Film .082µf, 80V, ±10%	802765	56289	192P8239R8	1
C19	Same as C1				
C20	Same as C17				
C21	Same as C13				
C22	Same as C2				
C23	Same as C13				
C24	Capacitor, Tantalum 47µf, 20V, ±10%	883231	06751	TS3K-20-476	1
C25	Same as C14				
CR1	Diode	807463	04713	1N4154	1
R1	Resistor, Composition 1kΩ, 1/4W, ±5%	880084	01121	CB1025	3
R2	Resistor, Composition 510Ω, 1/4W, ±5%	880082	01121	CB5115	8

Replacement Parts List: Control Card Assembly - 786615 (Continued)

Ref. Des.	Description	NAI Part No.	Code Ident.	Mfr. Part No.	Total Qty
R3	Resistor, Composition 10kΩ, 1/4W, ±5%	880092	01121	CB1035	8
R4	Same as R2				
R5	Same as R3				
R6	Same as R3				
R7	Same as R3				
R8	Same as R2				
R9	Same as R2				
R10	Resistor, Composition 51kΩ, 1/4W, ±5%	880559	01121	CB5135	1
R11	Same as R3				
R12	Resistor, Composition 8.2kΩ, 1/4W, ±5%	880091	01121	CB8225	2
R13	Same as R2				
R14	Same as R12				
R15	Same as R2				
R16	Same as R3				
R17	Same as R2				
R18	Same as R3				
R19	Same as R2				
R20	Same as R3				
R21	Same as R1				
R22	Same as R1				
R23	Resistor, Composition 100Ω, 1/4W, ±5%	880077	01121	CB1015	1
U1	Integrated Circuit	883235	01295	SN74LS02N	2
U2[1]	Integrated Circuit	880018	73138	899-5R220/330	1
U3	Integrated Circuit	808341	01295	SN74LS04N	3
U4	Same as U1				
U5	Integrated Circuit	883236	01295	SN74LS08N	3
U6	Integrated Circuit	883237	01295	SN74LS10N	1
U7	Integrated Circuit	883238	01295	SN74LS27N	1
U8	Integrated Circuit	880063	01295	7438	2

[1] Optional

Replacement Parts List: Control Card Assembly - 786615 (Continued)

Ref. Des.	Description	NAI Part No.	Code Ident.	Mfr. Part No.	Total Qty
U9	Integrated Circuit	808137	01295	SN74LS00N	3
U10	Integrated Circuit	883239	02195	SN74LS279N	2
U11	Integrated Circuit	883240	01295	SN74LS74N	3
U12	Integrated Circuit	880057	01295	7404N	1
U13	Integrated Circuit	808135	01295	SN74LS13N	1
U14	Integrated Circuit	883210	12040	NE558F	2
U15	Integrated Circuit	883241	01295	SN74LS123N	1
U16	Integrated Circuit	883242	01295	SN74LS11N	1
U17	Same as U3				
U18	Same as U8				
U19	Same as U5				
U20	Same as U14				
U21	Same as U3				
U22	Same as U11				
U23	Same as U11				
U24	Same as U9				
U25	Same as U10				
U26	Same as U5				
U27	Same as U9				
XU2[1]	Socket, IC 14-pin	807473	01295	C931402	1
XU28	Socket, IC 16-pin	880462	09097	N2706-02	1

[1] Optional

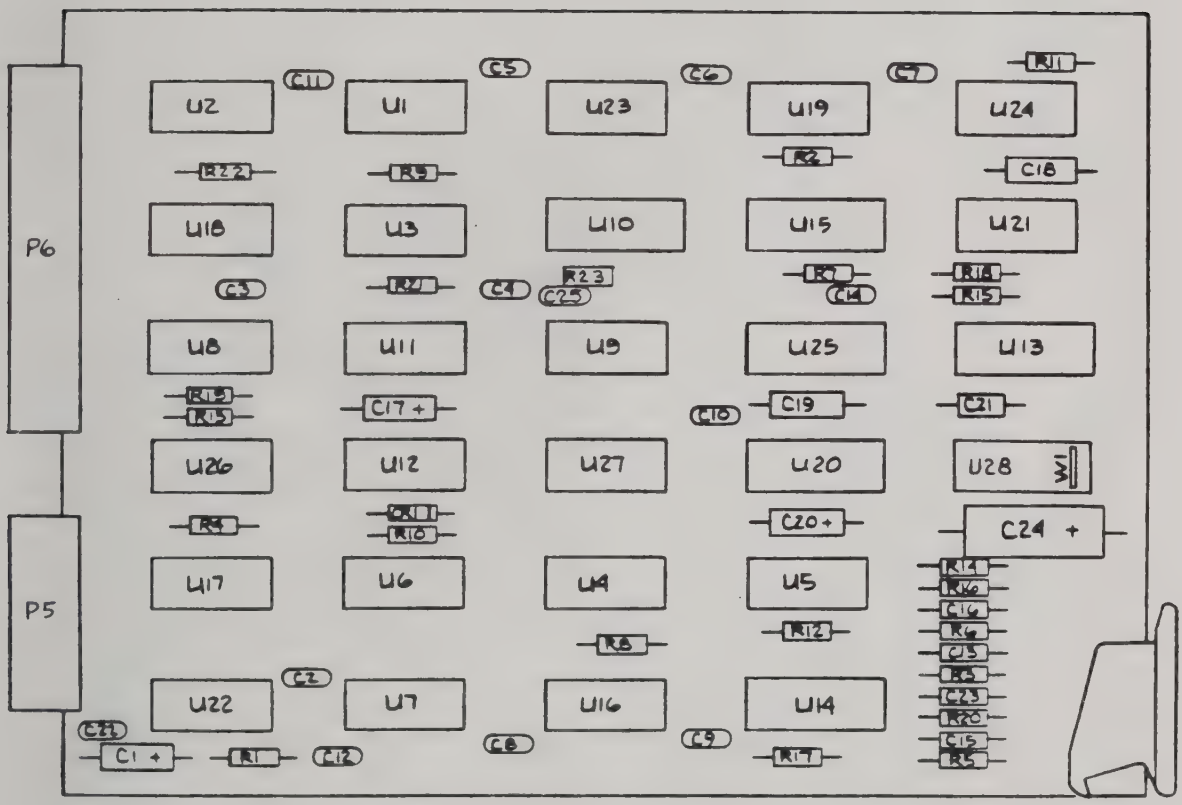


Figure 6-7. Control Card, Parts Locator

SECTION 7

UNIT SCHEMATICS

This section contains schematic diagrams for all units of the Model 200 Minidrive.

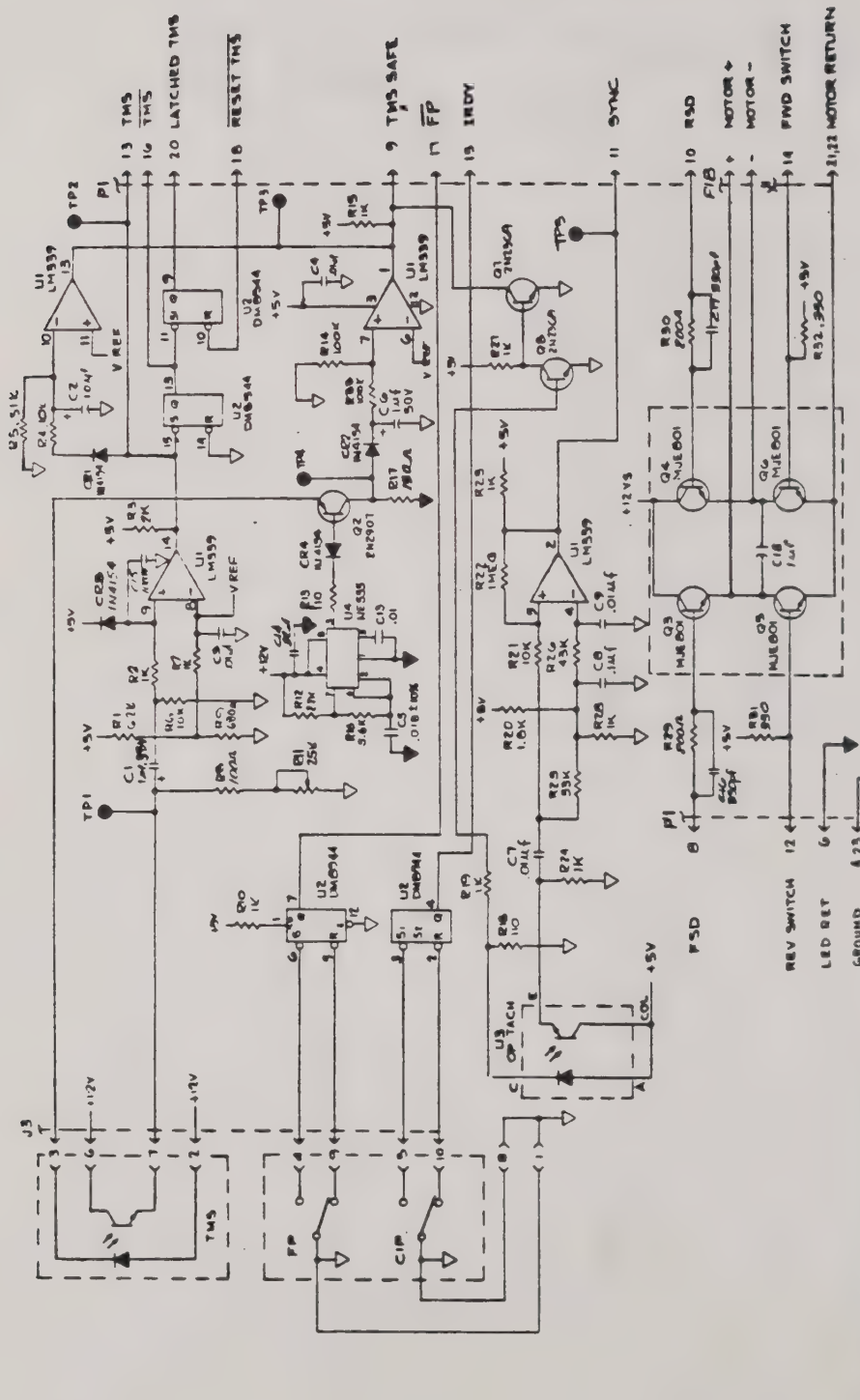


Figure 7-1. Status Drive, Schematic

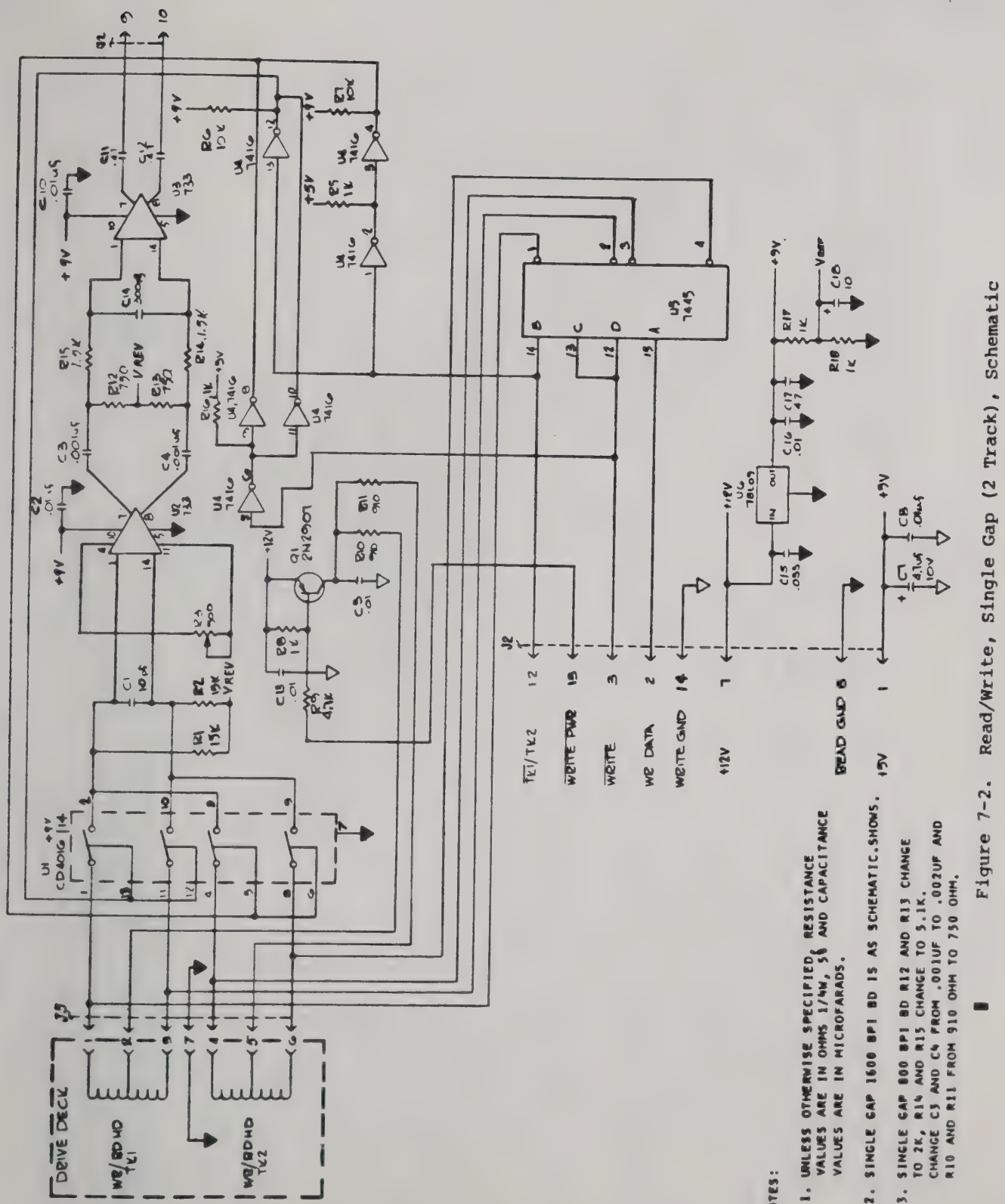
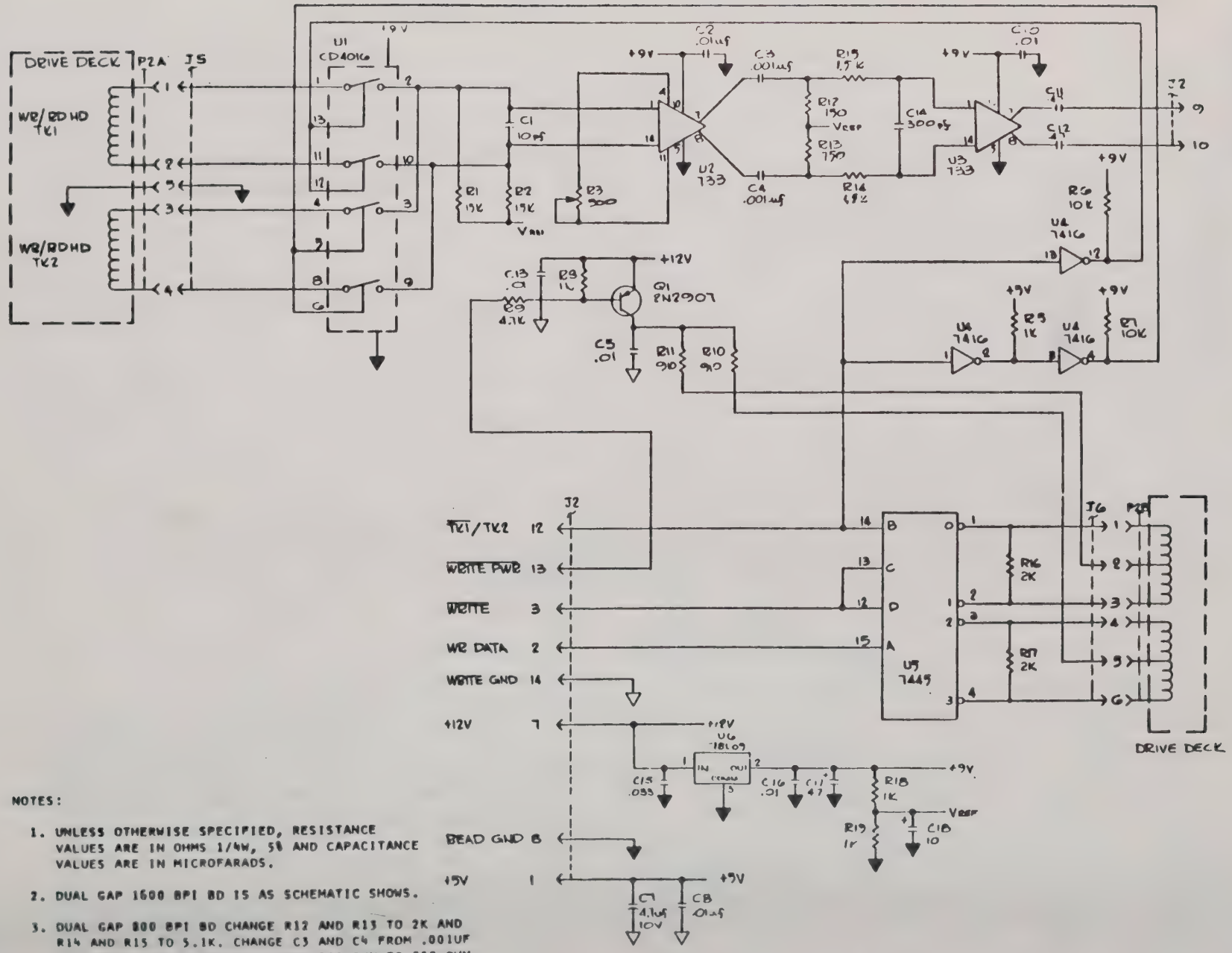

DRIVE DECK
WR/RDHD TK1
WR/RDHD TK2
TK1/TK2
WRITE PWR
WRITE
WR DATA
WRITE GND
+12V
READ GND
+5V
NOTES:
1. UNLESS OTHERWISE SPECIFIED, RESISTANCE VALUES ARE IN OHMS 1/4W, 5% AND CAPACITANCE VALUES ARE IN MICROFARADS.
2. SINGLE GAP 1600 BPI RD IS AS SCHEMATIC.SHOWS.
3. SINGLE GAP 800 BPI RD R12 AND R13 CHANGE TO 2K, R14 AND R15 CHANGE TO 5.1K. CHANGE C3 AND C4 FROM .001UF TO .002UF AND R10 AND R11 FROM 910 OHM TO 750 OHM.

Figure 7-2. Read/Write, Single Gap (2 Track), Schematic



NOTES:

1. UNLESS OTHERWISE SPECIFIED, RESISTANCE VALUES ARE IN OHMS 1/4W, 5% AND CAPACITANCE VALUES ARE IN MICROFARADS.
2. DUAL GAP 1600 BPI BD IS AS SCHEMATIC SHOWS.
3. DUAL GAP 800 BPI BD CHANGE R12 AND R13 TO 2K AND R14 AND R15 TO 5.1K. CHANGE C3 AND C4 FROM .001UF TO .002UF AND R10 AND R11 FROM 910 OHM TO 750 OHM.

Figure 7-3. Read/Write, Dual Gap (2 Track), Schematic

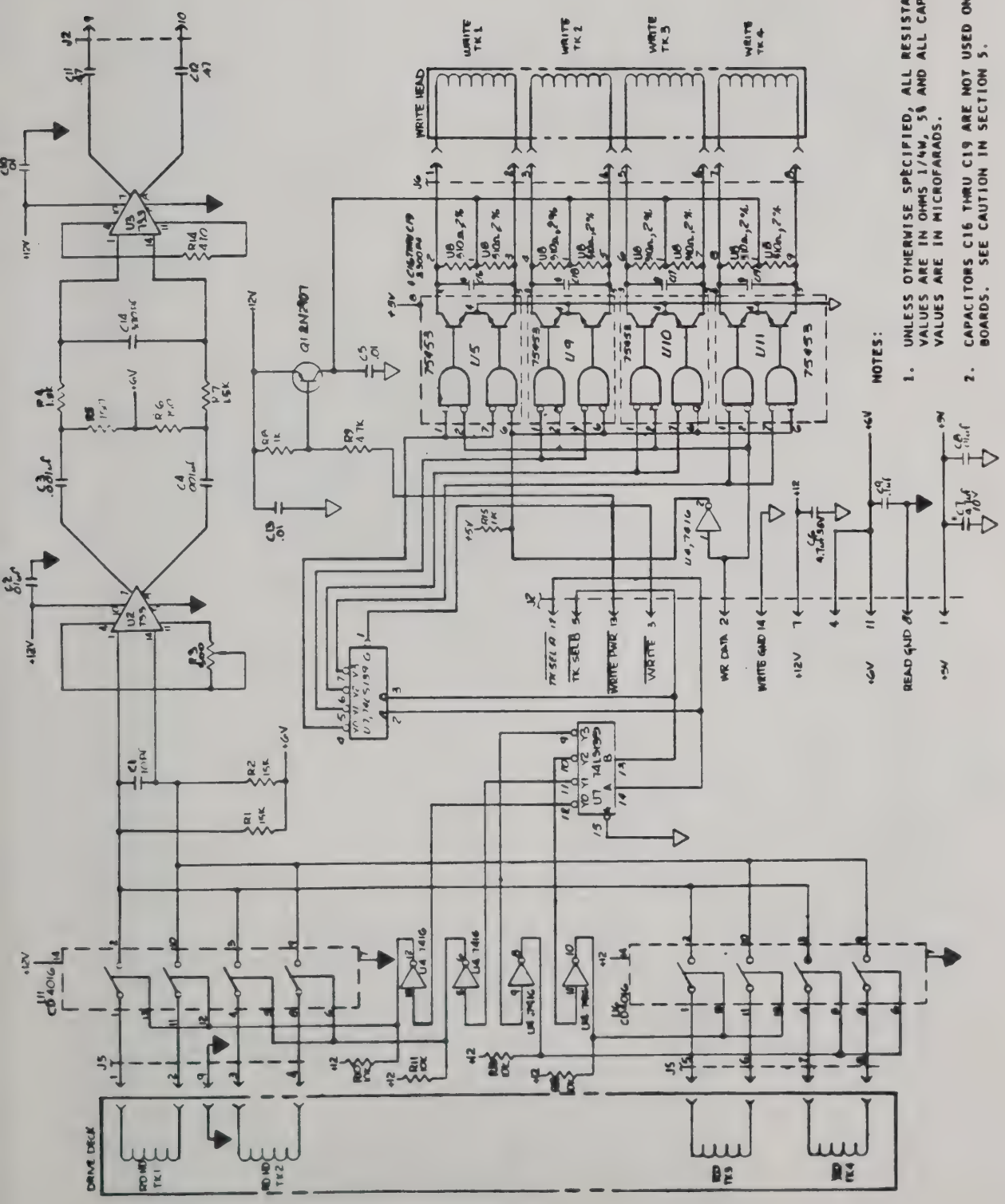

WRITE HEAD
WRITE TK1
WRITE TK2
WRITE TK3
WRITE TK4
NOTES:
1. UNLESS OTHERWISE SPECIFIED, ALL RESISTANCE VALUES ARE IN OHMS 1/4W, 5% AND ALL CAPACITANCE VALUES ARE IN MICROFARADS.
2. CAPACITORS C16 THRU C19 ARE NOT USED ON ALL BOARDS. SEE CAUTION IN SECTION 5.
WR DATA
WRITE GND
READ GND
DRIVE DECK

Figure 7-4. Read/Write, Dual Gap (4 Track), Schematic

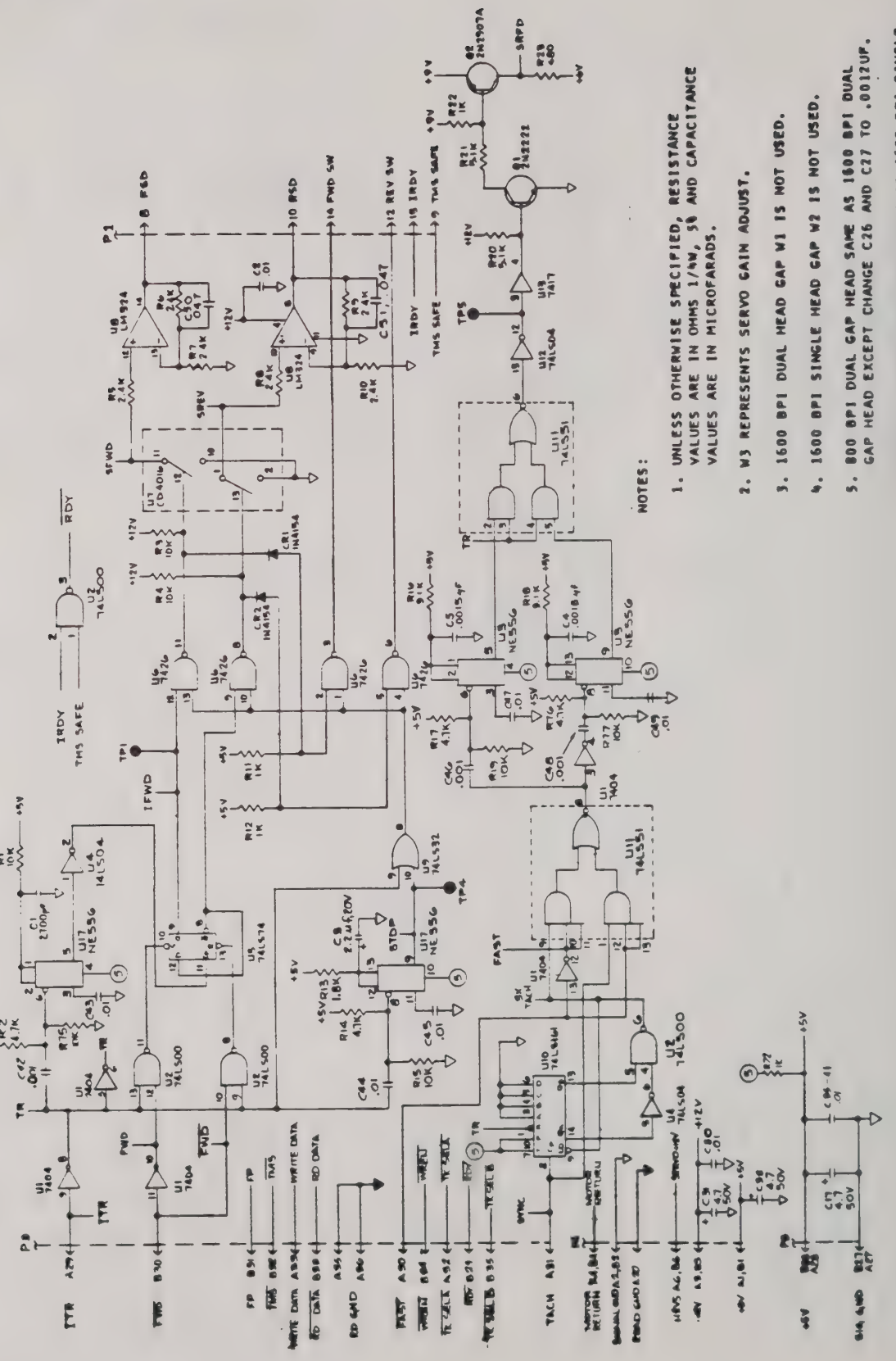

NOTES:
1. UNLESS OTHERWISE SPECIFIED, RESISTANCE VALUES ARE IN OHMS 1/4W, 5% AND CAPACITANCE VALUES ARE IN MICROFARADS.
2. W3 REPRESENTS SERVO GAIN ADJUST.
3. 1600 BPI DUAL HEAD GAP W1 IS NOT USED.
4. 1600 BPI SINGLE HEAD GAP W2 IS NOT USED.
5. 800 BPI DUAL GAP HEAD SAME AS 1600 BPI DUAL GAP HEAD EXCEPT CHANGE C26 AND C27 TO .0012UF.
6. 800 BPI SINGLE GAP HEAD SAME AS 1600 BPI SINGLE GAP HEAD EXCEPT CHANGE C26 AND C27 TO .0012UF.

Figure 7-5. Servo/Data Board, (Sh.1 of 2), Schematic

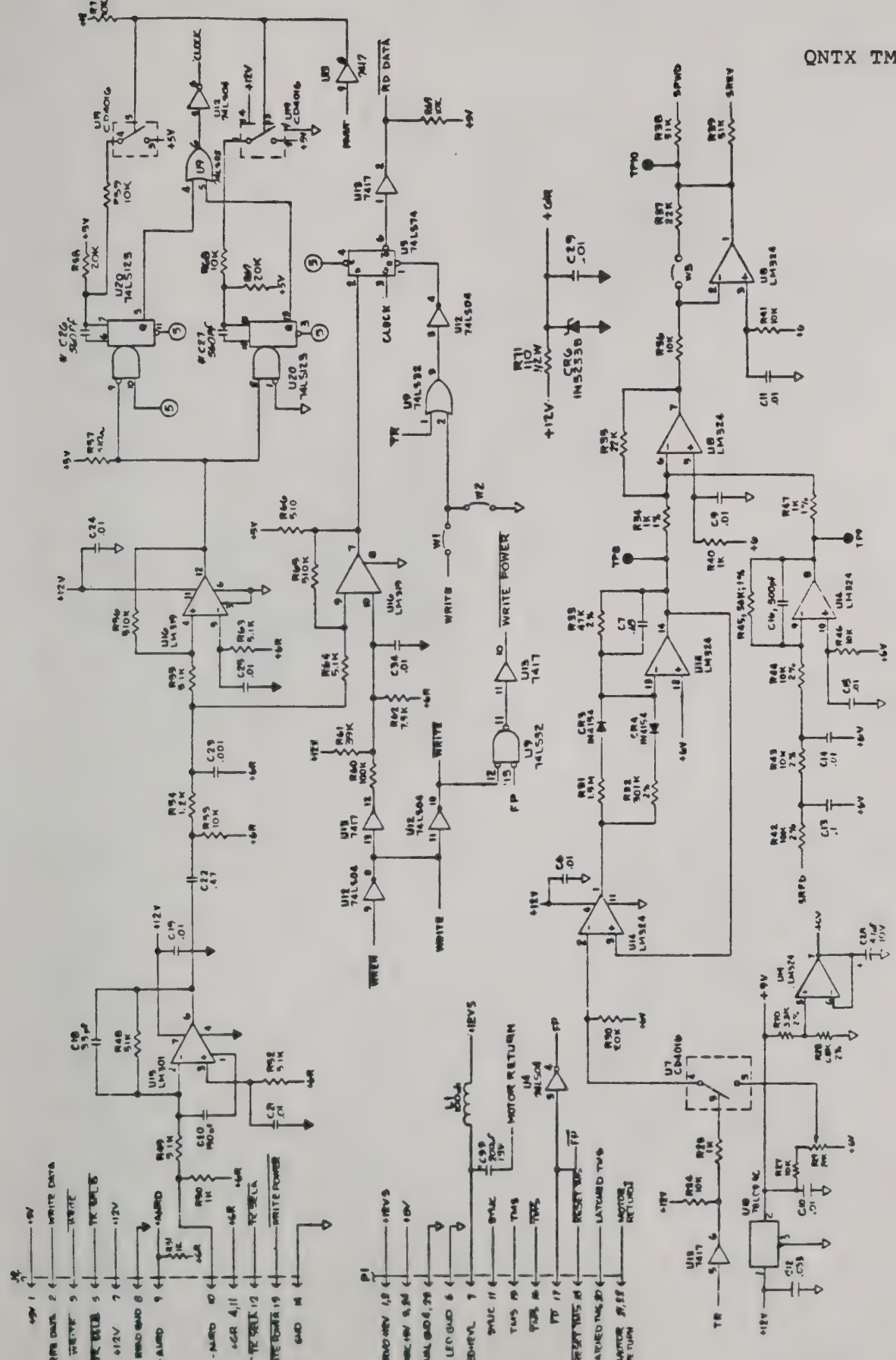


Figure 7-5. Servo/Data Board (Sh. 2 of 2), Schematic

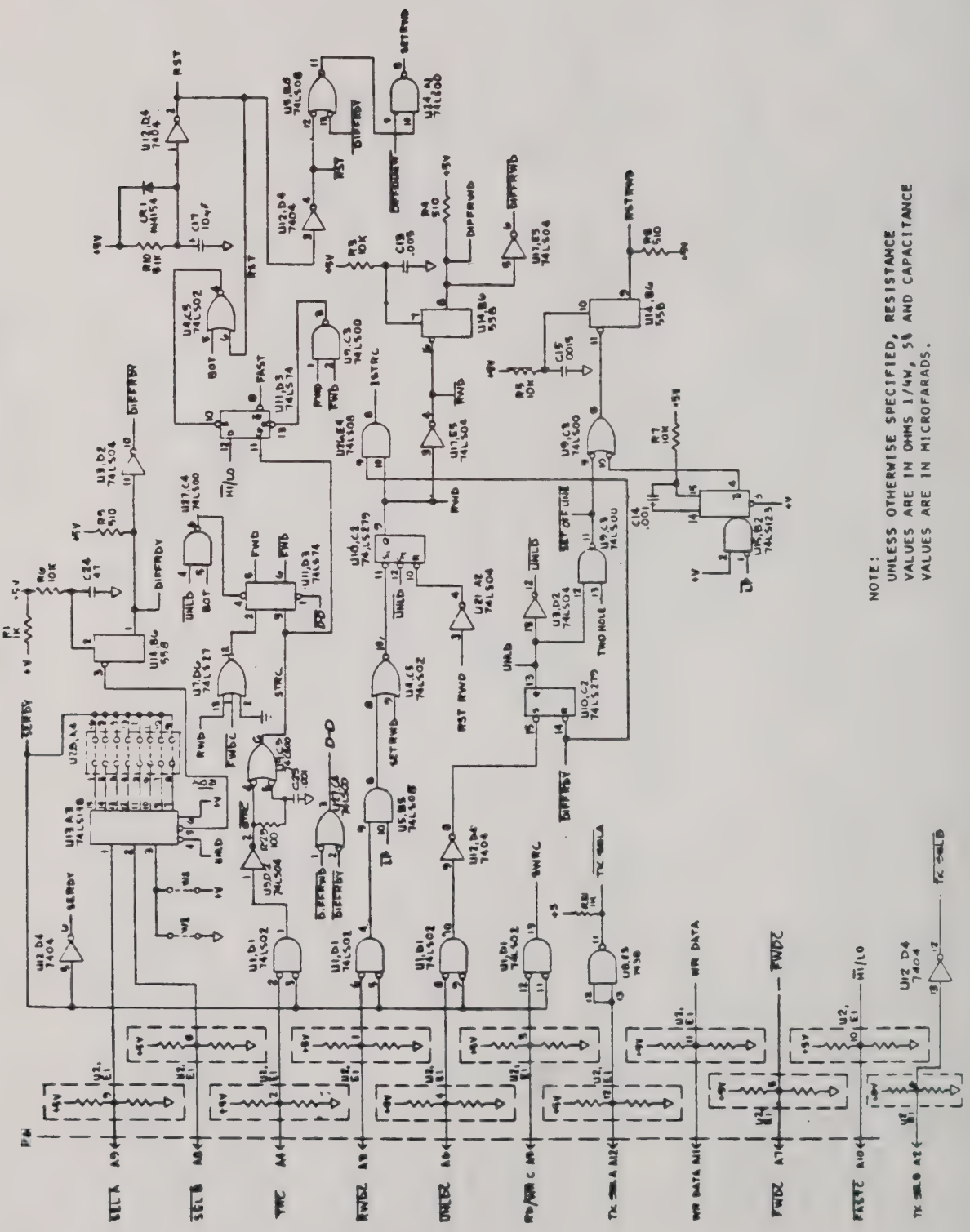


Figure 7-6. Control Card (Sh. 1 of 2), Schematic

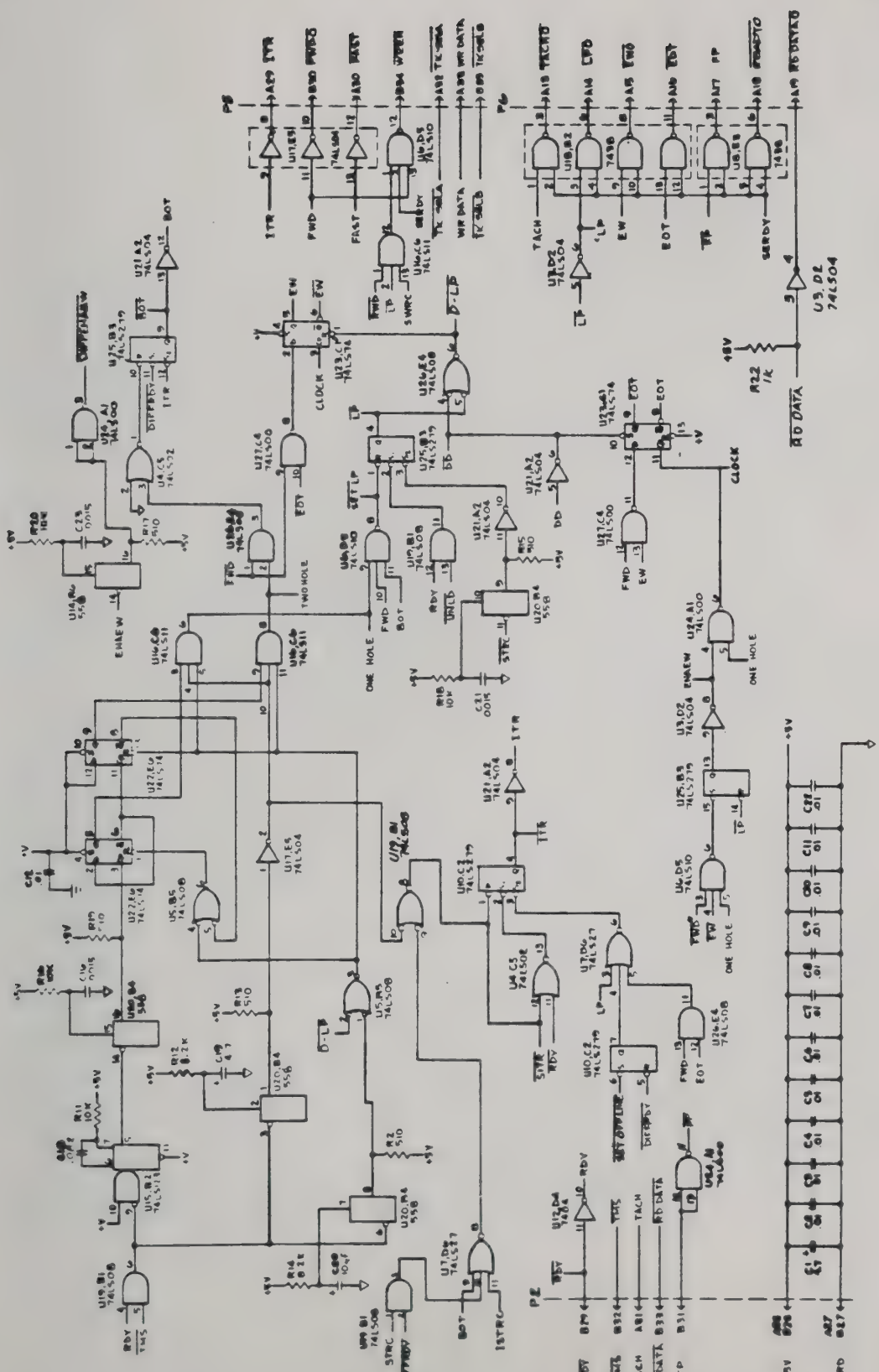


Figure 7-6. Control Card (Sh. 2 of 2), Schematic

APPENDIX A

MANUAL CHANGE DATA

A.1 INTRODUCTION

This appendix contains information necessary to backdate the manual to conform with earlier assembly configurations. To identify the configuration of the assembly used in your unit, refer to the revision letter on the solder side of each assembly. Table A-1 defines the assembly revision levels documented in this manual with an X.

A.2 NEWER UNITS

As changes and improvements are made to the unit they are identified by incrementing the revision letter or number marked on the affected assembly. These changes are documented on a Product Revision Sheet which, when applicable, is inserted at the front of the manual.

A.3 OLDER UNITS

To backdate this manual to conform with earlier assembly revision levels, perform the changes indicated in table A-1 in descending order.

Table A-1. Manual Status and Backdating Information

Assembly Name	NAI Part No.	To adapt manual to earlier rev configurations perform change numbers in descending order (by no.), ending with change under desired rev letter.													
		C1	D1	E	E1	F	F1	G	G1	H	H1	J	K	T1	U
Status Drive	786087													2	X
Read/Write Board	786636	1										X			
Read/Write Board	786609	1										X			
Read/Write Board	786634		3										X		
Read/Write Board	786608				3								X		
Read/Write Board	786807			X											
Servo/Data Board	786635							4	X						
Servo/Data Board	786660					4	X								
Servo/Data Board	786616									4	X				
Servo/Data Board	786661							4	X						
Control Board	786615											X			

X=the assembly revision levels documented in this manual.
Numbers represent changes described in the following pages.

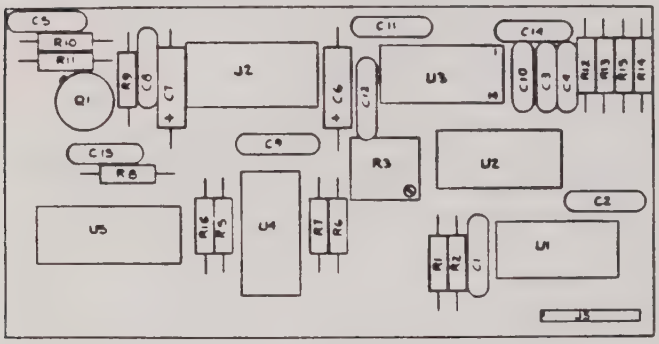
CHANGE 1 - READ/WRITE BOARD 786636, 786609 (PCR 21675)

1. Add C6, 4.7µf (NAI P/N 801116) and C9, 0.1µf, (NAI P/N 880636) to the read/write board parts list.

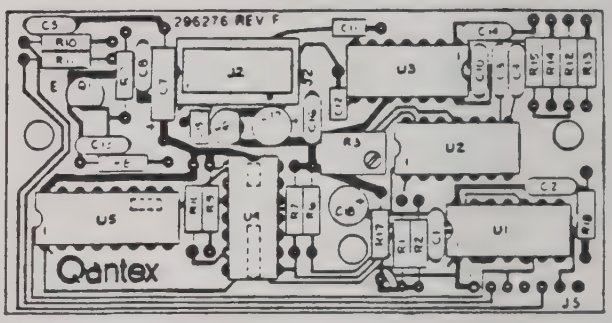
2. Delete the following components from the read/write parts list:

   C15, C16, C17, C18, R17, R18, U6

3. Change figure 6-3 as shown below:

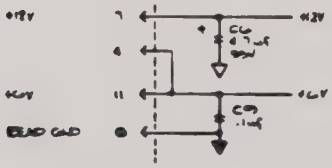


IS



WAS

4. Change figure 7-2 as shown below. Also change +9V reference at U1, U2, U3, R6, and R7 to +12V reference, and V_{REF} at R12, R13, and at R1, R2 to +6V.



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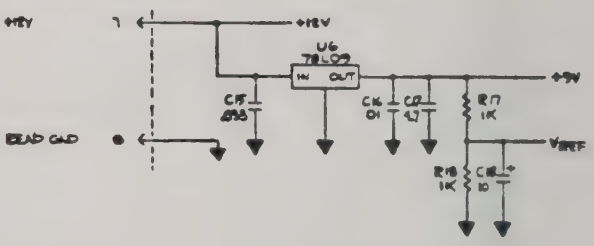


WAS

CHANGE 2 - STATUS DRIVE 786087 (PCR 22172)

1. In the status drive parts list, change R24 from 880084 (1kΩ) to NAI P/N 880089 (5.1kΩ).

2. In figure 7-1, change value of R24 from 1K to 5.1K.

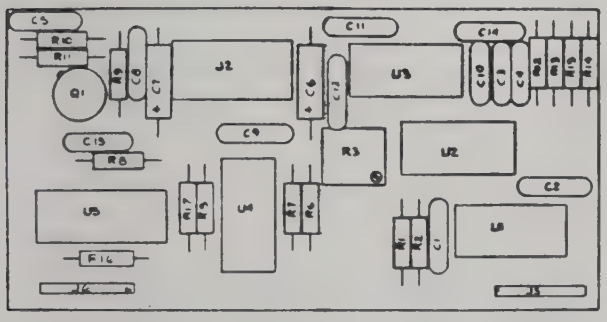
CHANGE 3 - READ/WRITE BOARD 786608, 786634 (PCR 21676)

1. Add C6, 4.7µf (NAI P/N 801116) and C9, 0.1µf (NAI P/N 880036) to the read/write board parts list.

2. Delete the following components from the read/write board parts list:

   C15, C16, C17, C18, R18, R19, U6

3. Change figure 6-4 as shown below:



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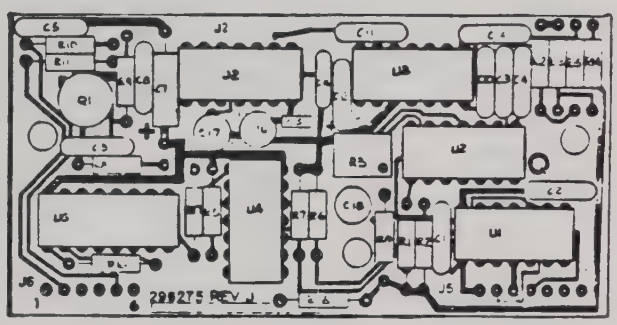
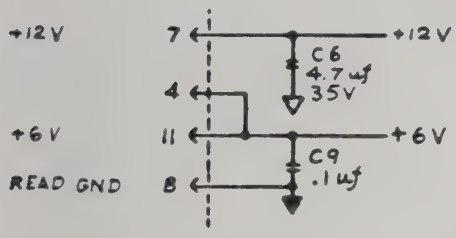


WAS

4. Change figure 7-3 as shown below. Also change all +9V references to +12V except at Q1 emitter. Change V_{REF} (at junction of R1, R2) to +6 V.



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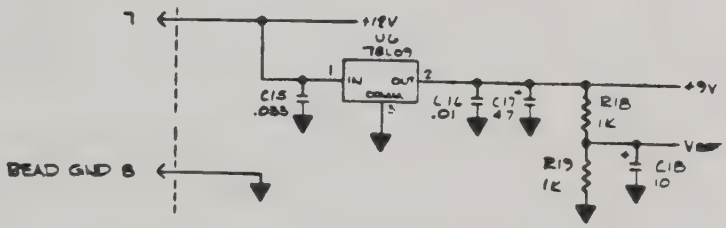


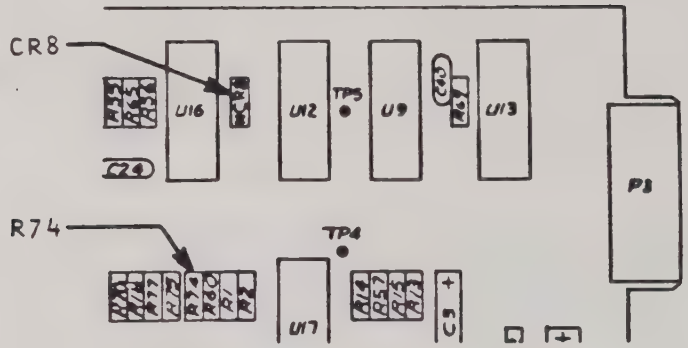
WAS

CHANGE 4 - SERVO/DATA BOARDS 786616, 786635, 786660, 786661 (PCR 22475)

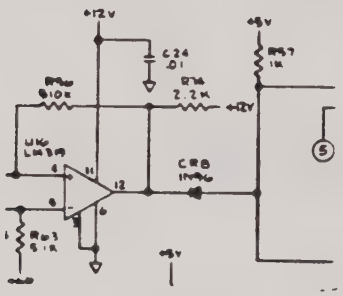
1. Add CR8, 1N96 (NAI P/N 801013) and R74, 2.2K ohm (NAI P/N 802230) to the servo/data board parts list.

2. In the servo/data board parts list, change R57 NAI P/N 880082 (510 ohm, 1/4W, ±5%) to NAI P/N 880084 (1K, 1/4W, ±5%).

3. Add CR8 and R74 to figure 6-6 as shown below:



4. Change figure 7-5 (sheet 2 of 2) as shown below:



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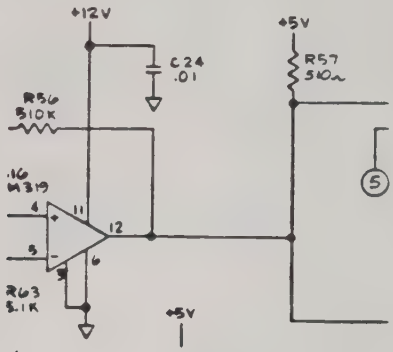


WAS

LIMITED WARRANTY

A. The seller warrants products against defects in material and workmanship for six months from the date of original shipment. The seller's liability is limited to the repair or replacement of products which prove to be defective during the warranty period. There is no charge under the warranty except for transportation charges. The purchaser shall be responsible for products shipped until received by the seller.

B. The seller specifically excludes from the warranty 1) calibration, 2) fuses, 3) source inspection, 4) test data, 5) normal mechanical wear, e.g.: end-of-life on assemblies such as switches, printheads, recording heads, etc. is dependent upon number of operations or hours of use, and end-of-life may occur within the warranty period.

C. The seller is not liable for consequential damages or for any injury or damage to persons or property resulting from the operation or application of products.

D. The warranty is voided if there is evidence that products have been operated beyond their design range, improperly installed, improperly maintained or physically mistreated.

E. The seller reserves the right to make changes and improvements to products without any liability for incorporating such changes or improvements in any products previously sold, or for any notification to the purchaser prior to shipment. In the event the purchaser should require subsequently manufactured lots to be identical to those covered by this quotation, the seller will, upon written request, provide a quotation upon a change control program.

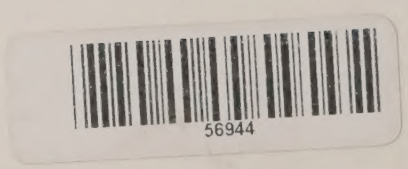
F. No other warranty expressed or implied is offered by the seller other than the foregoing.

CLAIMS FOR DAMAGE IN SHIPMENT

The purchaser should inspect and functionally test the product(s) in accordance with the instruction manual as soon as it is received. If the product is damaged in any way, including concealed damage, a claim should be filed immediately with the carrier, or if insured separately, with the purchaser's insurance company.

SHIPPING

On products to be returned under warranty, await receipt of shipping instructions then forward the instrument prepaid to the destination indicated. The original shipping containers with their appropriate blocking and isolating material is the preferred method of packaging. Any other suitably strong container may be used providing the product is wrapped in a sealed plastic bag and surrounded with at least four inches of shock absorbing material to cushion firmly, preventing movement inside the container.



north atlantic

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